DANA®

# Instruction Manual

980241

# MODEL 2850 DATA AMPLIFIER

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# MODEL 2850

# DATA AMPLIFIER

**August, 1967**

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DANA®

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**Publication**

**980241**

# *Warranty*

Within one year of purchase, Dana Laboratories will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Dana Laboratories. Just call Dana Product Service at our toll free number (800)854-3288, or (714)833-1234 collect in California, for assistance. We will advise the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

DANA

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## SECTION 1

## GENERAL DESCRIPTION

### 1.1 INTRODUCTION

The Dana Model 2850 is a direct-coupled, active guard differential amplifier with low noise at gains up to 2500 (12500 on 2850 V3 option), a high level of common mode rejection, and fast settling time. Full scale output is ±10 volts and ±100mA.

The Model 2850 features variable bandwidth with three pole 18dB/octave filtering. The input, output, and power supply contain RF interference suppression from external RF noise. The Model 2850 provides complete isolation between the two input leads and output common. No common mode return path is required to achieve a common-mode rejection of 120dB, dc to 60 Hz. If desired, the Model 2850 amplifier may also be used as a single-ended unit, inverting or non-inverting, in applications in which either the source or the load is isolated from ground.

A front-panel bandwidth control allows the output to be set at any one of five selected bandwidths: 10Hz, 100Hz, 1kHz, 10kHz, and wideband.

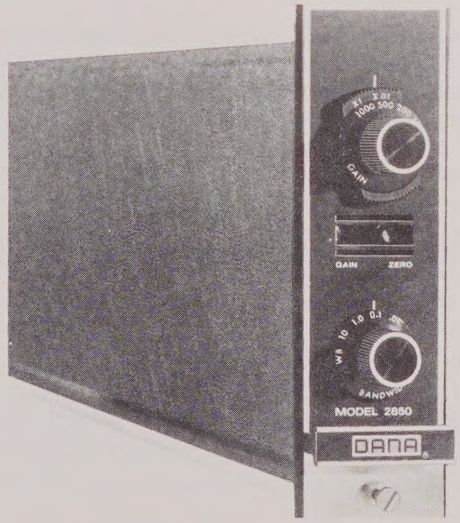



Figure 1.1 - Model 2850 V2 Data Amplifier

Fail-safe circuits within the amplifier prevent damage from short circuits and from fault voltages up to 60 volts common mode (250 $V_{CM}$ on low-gain settings) and 30 volts normal mode. Overload recovery is 2 milliseconds from 500% overload of any duration. The step-function settling time is 500 microseconds.

System noise contributed by the amplifier circuitry is exceptionally low. The noise referred to the input (RTI) at a gain of 1000 is less than 2 microvolts rms at full bandwidth and less than 1 millivolt referred to output (RTO), peak-to-peak, at a 10Hz bandwidth.

## 1.2 OPERATIONAL DESCRIPTION

A block diagram of the Model 2850 is shown in Figure 1.2. The Input Amplifier contains a Normal Mode Amplifier (NMA) and a Common Mode Amplifier (CMA). The NMA is a differential amplifier that amplifies the differential input voltage. Common mode voltage is effectively "cancelled out" in the NMA by feedback from the CMA. The CMA does this by sensing the common mode component of the signal in the first stage of the NMA and supplying an opposing voltage. The Output Amplifier consists of direct-coupled circuitry that determines the output characteristics of the amplifier. A portion of the output signal is applied back to the NMA through a precision attenuator network as negative feedback to define the closed-loop characteristics of the instrument. Amplifier gain is set by a voltage divider in the feedback network. Precision resistors are switched into this circuit by the GAIN switch.

The Variband* Filter is an Output Amplifier with an active filter amplifier. Capacitors in the filter amplifier are switched with each position of the BANDWIDTH switch to set the upper limit of each bandwidth. The Output Amplifier is capable of delivering $\pm$10 volts full scale output; full scale current output is 100 milliamperes.

## 1.3 GAIN OPTIONS

Gain controls include specific gain settings, plus a vernier that covers a range equal to 2-1/2 times the nominal gain setting. The result is a continuously variable gain from the lowest setting to 2-1/2 times the highest setting, and it allows the amplifier gain to be used for normalizing ratios, in the case of ratiometer measurements, or scaling a galvanometer trace.

Three gain options are available for various applications and must be specified when ordering the amplifier. They are designated as options V1, V2, and V3.

### 1.3.1 Option V1

The V1 Option provides gain steps of 20, 50, 100, 200, 500, and 1000. A vernier multiplier extends each gain by a factor of 2.5:1. The V1 Option is especially suited in applications where low-level, millivolt signals are to be amplified to voltage levels for accurate recording or measuring.

*Trademark

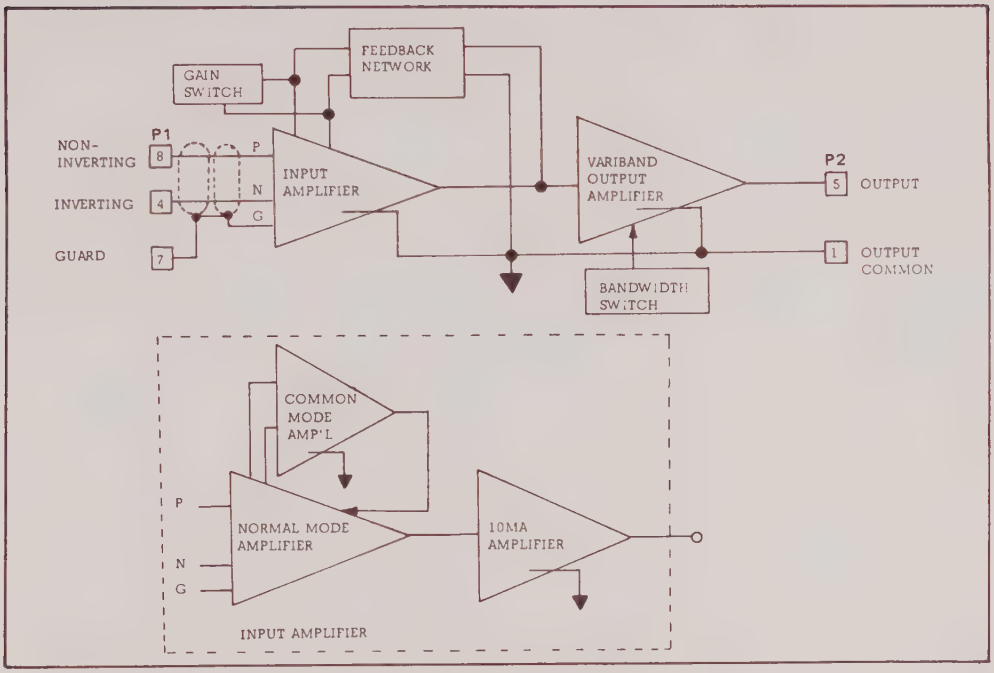



Figure 1.2 - Block Diagram, Model 2850

### 1.3.2 Option V2

The V2 Option provides the same gain steps as the V1 Option with a gain vernier to extend each gain by a factor of 2.5:1. Option V2, however, includes an X1/X.01 multiplier switch. This feature allows continuous selection of gain values over the range of 0.2 to 2500. The V2 option is especially suited for applications in which the input signal is already at a level of 1 volt or greater, or where the input may vary over a dynamic range from millivolts to full volts. Discriminators, potentiometers, and transformers are typical signal sources of this type and the amplifier serves as an isolation as well as scaling device.

### 1.3.3 Option V3

The V3 Option provides gain steps of 100, 200, 500, 1000, 2000, and 5000. A vernier multiplier extends each gain by a factor of 2.5:1. This feature allows continuous selection of gain values from 100 to 12,500. The V3 option is especially suited for applications that require an exceptionally high level of amplification such as a thermocouple temperature measuring system.

## 1.4 SPECIFICATIONS

Specifications are listed in Table 1.1.

# Table 1.1. Specifications

DANA MODEL 2850 SPECIFICATIONS

All specifications apply for 0 to 350 ohm sources, in any unbalance.

| Gain Option | Range | Steps | Accuracy | Resolution | Stability (at gain setting and constant temperature) | Temperature Coefficient |
|---|---|---|---|---|---|---|
| V-1 | 20 to 2500 with 2.5:1 vernier | 20,50,100,200, 500, 1000 | ±0.1% | ±0.01%(±0.1% worst case) | ±0.01% (200 hours) | ±0.005%/°C |
| V-2 | 0.2 to 2500 with 2.5:1 vernier | 0.2,0.5,1,2,5, 10,20,50,100, 200,500,1000 | ±0.1% | ±0.01% (±0.1% worst case) | ±0.01% (200 hours) | ±0.005%/°C |
| V-3 | 100 to 12,500 2.5:1 vernier | 100,200,500, 1000,2000,5000 | ±0.1% K≤1000, ±0.15% K>1000 | ±0.01% (±0.1% worst case) | ±0.01% (200 hours) K≤1000; ±0.01% x K/1000 (200 hrs) K>1000 | ±0.005%/°C |

| | Gain (K) 20 to 1000 | Gain (K) over 1000 | Gain (K) below 20 |
|---|---|---|---|
| OUTPUT (no damage for sustained short circuit) | | | |
| Full scale voltage | ±10V | ±10V | ±10V |
| Voltage overrange, nominal | 20% | 20% | 20% |
| Full scale load current | ±100mA | ±100mA | ±100mA |
| Maximum short circuit current | ±150mA | ±150mA | ±150mA |
| Impedance | 0.1 ohm in series with 150uH | 0.1 ohm in series with 150uH | 0.1 ohm in series with 150uH |
| Capacitive load, without instability | 1uF | 1uF | 1uF |
| Capability | Full scale voltage and current to 20kHz | Full scale voltage and current to 10kHz | Full scale voltage and current to 10kHz |
| FREQUENCY RESPONSE (at full output) | | | |
| Wideband dc to 100Hz | ±0.01% | ±0.02% | ±0.01% |
| Minimum 3dB frequency | 20kHz | 10kHz | 10kHz |
| Variband | | | |
| Filter characteristics | 3 pole Bessel | 3 pole Bessel | 3 pole Bessel |
| Switch selectable cutoff frequencies ($f_{co}$) of | 10Hz, 100Hz, 1kHz, 10kHz | 10Hz, 100Hz, 1kHz, 10kHz | 10Hz, 100Hz, 1kHz, 10kHz |
| Attenuation at selected $f_{co}$ | -3dB ±1dB | -3dB ±1dB | -3dB ±1dB |
| Attenuation above selected $f_{co}$ | -60dB/decade | -60dB/decade | -60dB/decade |
| Linearity (dc to 2kHz) | ±0.01% | $\pm 0.005\% \times \frac{K}{1000}$ | ±0.01% |
| COMMON MODE | | | |
| Rejection ratio dc to 60Hz | 120dB, K = 1000 60dB + K in dB for all other gains | 120dB, any gain | 60dB, K = 10 40dB + K in dB for all other gains |
| Operating voltage dc to 60Hz | 10V dc or peak ac | 10V dc or peak ac | 10V dc or peak ac |
| Fault voltage dc to 60Hz without damage | 60V dc or peak ac | 60V dc or peak ac | 60V dc or peak ac |
| NOISE | | | |
| Full bandwidth | 2uV rms RTI +2mV rms RTO | 2uV rms RTI +2mV rms RTO | 5mV rms RTO, any gain |
| 10Hz | 1mV peak to peak RTO, any gain | 1mV peak to peak RTO, any gain | 5mV peak to peak RTO, any gain |
| INPUT IMPEDANCE | | | |
| Normal mode | 10Megohm, parallel with 0.002uF | 10Megohm, parallel with 0.002uF | 1Megohm, parallel with 0.002uF |
| ZERO STABILITY | | | |
| At constant temperature (after 30 minute warm-up) | ±0.02% (200 hrs) | $\pm 0.02\% \times \frac{K}{1000}$ (200 hours) | ±0.1% (40 hours) |
| Temperature coefficient | (±0.0015% RTO ±1uV RTI)/°C | (±0.0015% RTO ±1uV RTI)/°C | (±0.0015% RTO ±500uV RTI)/°C |
| STEP FUNCTION RESPONSE | | | |
| Settles to final value ±0.1% of full scale in | $500\ \mu sec + \frac{1.4}{f_{co}}$ sec | $1\ msec + \frac{1.4}{f_{co}}$ sec | $500\ \mu sec + \frac{1.4}{f_{co}}$ sec |
| Overload Recovery (to final value ±0.1% of full scale ±10uV RTI) 5 times full scale input, no damage for 30V dc or peak ac input on any gain | $2\ msec + \frac{1.4}{f_{co}}$ sec | $2\ msec + \frac{1.4}{f_{co}}$ | $2\ msec + \frac{1.4}{f_{co}}$ sec |
| TEMPERATURE RANGE (all options) | | | |
| Operating | 0°C to +50°C | | |
| Storage | -20°C to +75°C | | |
| POWER REQUIREMENT (all options) | | | |
| Domestic | 105 to 125V rms, 50 to 400Hz, 8 watts | | |
| Export Option 1 | 200 to 240V rms, 50 to 400Hz, 8 watts | | |
| Export Option 2 | 215 to 265V rms, 50 to 400Hz, 8 watts | | |
| Export Option 3 | 90 to 110V rms, 50 to 400Hz, 8 watts | | |

## 1.5 LOW-GAIN CONSIDERATIONS

For easier evaluation of accuracy at low-gain operation, pertinent specifications are tabulated in Table 1.2 — in terms of percentage of full scale.

Table 1.2

| Gain Setting | Zero Drift/Degree C as % of Full Scale | Error/Volt (Common Mode) as % of Full Scale |
|---|---|---|
| 1000 | 0.012% | 0.01% |
| 500 | 0.007 | 0.01 |
| 200 | 0.004 | 0.01 |
| 100 | 0.003 | 0.01 |
| 50 | 0.002 | 0.01 |
| 20 | 0.002 | 0.01 |
| 10 | 0.051 | 0.05 |
| 5 | 0.026 | 0.05 |
| 2 | 0.012 | 0.05 |
| 1 | 0.006 | 0.05 |
| 0.5 | 0.004 | 0.05 |
| 0.2 | 0.003 | 0.05 |

## 1.6 AMPLIFIER ENCLOSURES

The 2808 Enclosure accommodates eight amplifiers. The enclosure is 7 inches in height with a depth of 22 inches and a width, including flanges, of 19 inches. The basic model is modified by a "dash" number which specifies the type of wiring.

The 2808 Enclosure accommodates all of the Dana Series 2800 Amplifiers. The amplifiers are interchangeable in the enclosure without alteration of the input and output cables.

The -1 Enclosure contains connectors to accommodate system wiring. Fusing and AC wiring are factory wired. An outline drawing (452402) is included in Section 7, Drawings and Parts Lists.

The -2 Enclosure is fully wired. The inputs and outputs are accessible through connectors mounted on the rear panel. An outline drawing (452403) is included in Section 7, Drawings and Parts Lists.

**The model 2802-2 enclosure accomodates two 2800 series amplifiers. All 2800 series amplifiers are interchangeable in the enclosure without alteration of the input and output cables.**

**The 2802-2 can be adapted for bench use or for rack mount use. Dimensions of the enclosure are, height 3.5 inches, depth 20 inches, width 17 inches. Inputs and outputs are accessible through connectors mounted on the rear panel. An outline drawing (402619 page 1 of 3) is included in section 7, Drawings and Parts Lists.**

Wiring instructions for each type enclosure are included in Section 2, "Installation".

## 1.7 AMPLIFIER ACCESSORIES

An Adapter Set Model 2801 (Dana part number 402468) and an Amplifier Support Bracket (Dana part number 452411) are used when the amplifier is operated on the bench. The Adapter Set (item 1 in Figure 1.3) contains input leads, output leads, and the power cord. The Amplifier Support Bracket (item 2 in Figure 1.3) mounts to the amplifier to support the amplifier in an upright position.

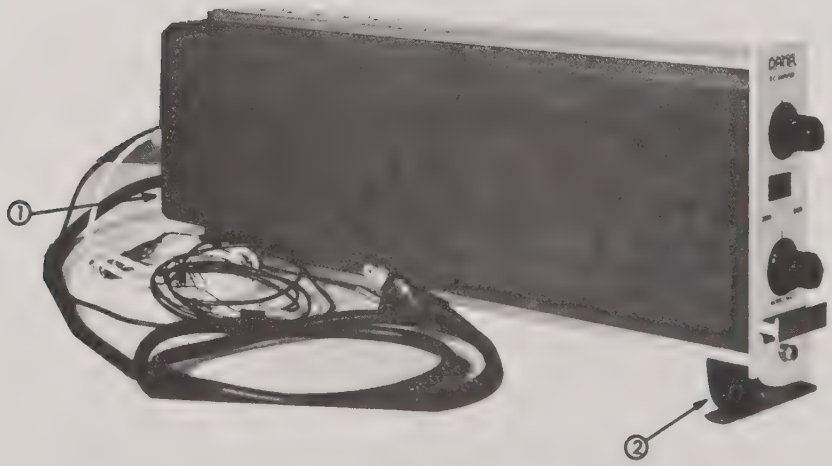



Figure 1.3 - Amplifier Accessories

# SECTION 2

# INSTALLATION AND CHECKOUT

## 2.1 UNPACKING AND INSPECTION

The Dana Amplifier is shipped in a special reusable shipping package, designed to protect the instrument from excessive shock and vibration. Examine the package for signs of external damage before removing the unit. If external damage is present, notify the carrier before proceeding. Next, examine the outside of the amplifier for any evidence of damage due to excessive shock, vibration, water leakage, etc.

If the unit appears in perfect condition, proceed with the installation. However, if there is any apparent damage, communicate with the carrier for instructions.

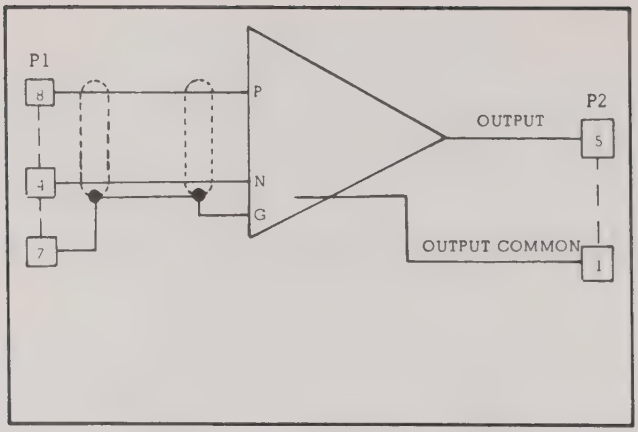
## 2.2 POWER REQUIREMENTS

Dana Amplifiers, manufactured for domestic use, operate on 115 volts (± 10 volts), 50 to 400 Hz. Units manufactured for export operate on 210 to 250 volts, 50 to 400 Hz. Power required is eight watts.

> NOTE
>
> If the Amplifier has been stored for a prolonged period (5 or 6 months) without use, it is recommended that it be operated with a variable transformer, such as a Variac, at one-half line voltage for about two hours before gradually applying full power. This is done to "reform" the electrolytic capacitors in the amplifier and reduce the chance of capacitor failure.

## 2.3 INPUT-OUTPUT CONNECTIONS

Input and output connections to the amplifier are through an eight pin connector (P1 and P2) at the rear of the amplifier (see Figure 2.1). External connections are brought in through a mating connector. When the Dana enclosures are used, the mating connector for each amplifier is mounted on the inside back panel of the enclosure; each amplifier plugs into its corresponding connectors. When amplifiers are used singly, a single unit adapter set is normally used. The adapter set (Dana part number 402468) includes the mating connector, power cord, and clip leads for input and output signal connections.



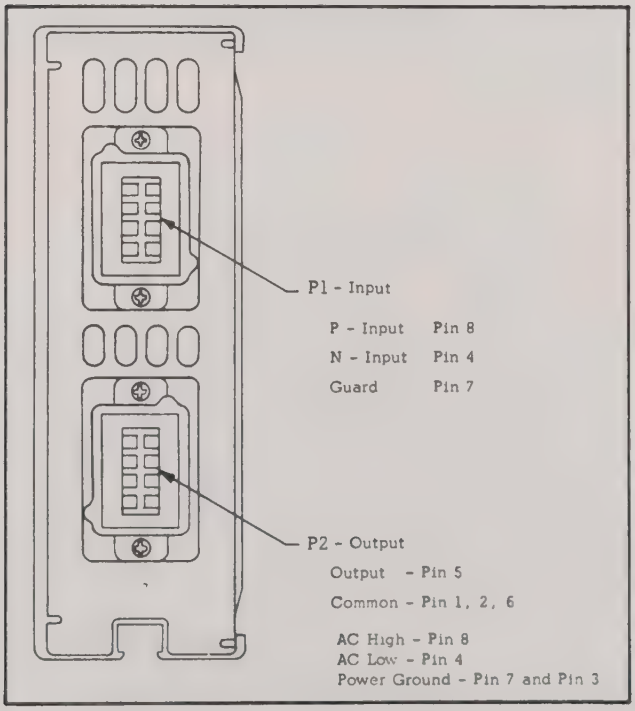


P1 - Input
P - Input Pin 8
N - Input Pin 4
Guard Pin 7
P2 - Output
Output - Pin 5
Common - Pin 1, 2, 6
AC High - Pin 8
AC Low - Pin 4
Power Ground - Pin 7 and Pin 3

Figure 2.1 - Input/Output Connections

When the 2808-1 Enclosure is used, external connections are made directly to the solder side of the enclosure mounted connector for each amplifier. Access to connectors is gained by removing four screws holding the rear panel and allowing the top of the rear panel to drop away from the enclosure. External leads are routed through the grommet holes and soldered to the connectors.

In the 2808-2 Enclosure, conventional cable connectors are mounted on the rear panel. Connections are made by wiring to the mating connector. All pin connections are identified in Figure 2.2.

### 2.3.2 Power

When the Amplifier is to be operated within the 2808-1 or 2802-2 Enclosure, power is prewired and a three-wire line cord is supplied. When using the cord set, power and input/output connections are prewired. The power cord is connected to J2 of the cord set.

The ground wire of the power cord connects to the internal power supply shield of the amplifiers.

### 2.3.3 Input/Output Signals

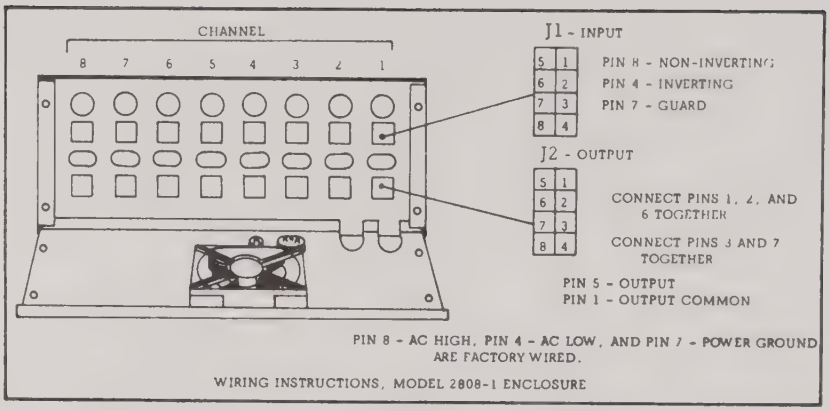
Input wiring configurations are extremely important in minimizing common mode voltages. The guard lead should be connected as close as possible to the signal source. Input and output connections are shown in Figure 2.2.

For permanent installations, low thermal solder (70% cadmium, 30% tin) should be used for all input connections to reduce thermal couple errors. For temporary or test setups, screw terminals or clips having low resistance may be used, taking suitable care to minimize thermal emf's (a few microvolts can be significant on high gain ranges).

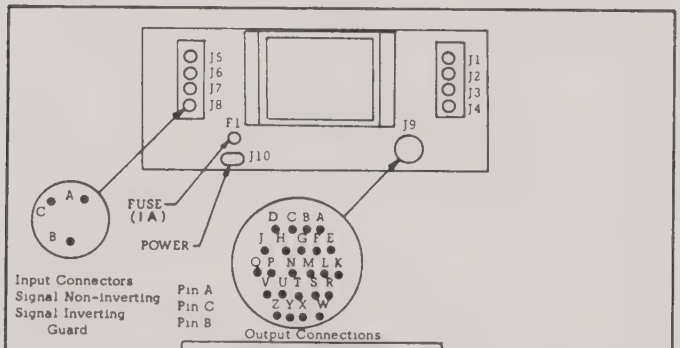
Since P and N inputs to the amplifier are symmetrical (approximately equal impedance to output common), either lead may be connected to either side of the signal source. For phasing purposes, if P is positive with respect to N, the output is positive with respect to output common.

Input leads should be two-conductor in an insulated shielded cable (Belden #8451-500, or equivalent). The shield must be soldered to the guard pin connection (pin 7 of P1 when a -1 Enclosure is used; pin B of the signal input connector for a -2 Enclosure). The unshielded portion of the leads must be kept as short as possible.

A single-conductor shielded cable is recommended for output leads. If two-conductor is used, connect one lead and shield together at either end or both ends. Solder the shield to Output Common (pin 1 of P2 for -1 enclosures; see Figure 2.1 for -2 enclosures). The enclosure chassis is connected to ground by the power cable. The lead from the output common terminal of the amplifier should be connected directly to the input common or ground of the output device.


CHANNEL
8 7 6 5 4 3 2 1
J1 - INPUT
5 1
6 2
7 3
8 4
PIN 8 - NON-INVERTING
PIN 4 - INVERTING
PIN 7 - GUARD
J2 - OUTPUT
5 1
6 2
7 3
8 4
CONNECT PINS 1, 2, AND 6 TOGETHER
CONNECT PINS 3 AND 7 TOGETHER
PIN 5 - OUTPUT
PIN 1 - OUTPUT COMMON
PIN 8 - AC HIGH, PIN 4 - AC LOW, AND PIN 7 - POWER GROUND ARE FACTORY WIRED.

WIRING INSTRUCTIONS, MODEL 2808-1 ENCLOSURE




| CHANNEL | OUTPUT | OUTPUT COMMON |
|---|---|---|
| 1 | A | B |
| 2 | E | F |
| 3 | K | L |
| 4 | R | S |
| 5 | W | X |
| 6 | D | C |
| 7 | J | H |
| 8 | Q | P |

CHASSIS GROUND PIN Z

NOTES: (1) Use shielded two conductor twisted pair cable for input leads. Shield is soldered to Guard Pin Connection.

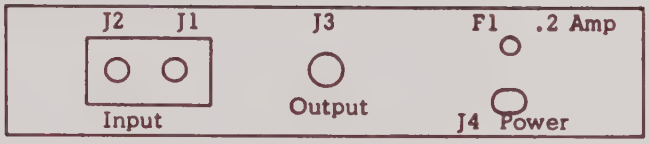
(2) Single conductor shielded wire is recommended for output leads. Solder shield to output common pin.

(3) Viewing enclosure from the front, amplifiers are numbered from left to right.

| | Mating Connector & Clamps | Dana Part Number |
|---|---|---|
| INPUT | 3106 A-10 SL-3S A10S-A11S | 601561 |
| (8 sets required) | 3057-4A-A10S w/Bush | 601474 |
| OUTPUT | 3106 A-24-28P-639 | 601563 |
| (1 set required) | 3057-16A-639 w/Bush | 601564 |
| AC POWER | Belden Power Cord #17256 | 600127 |
| (1 set required) | | |

Wiring Instructions, Model 2808-2 Enclosure

Figure 2.2 - Enclosure Wiring



Input Connectors

| | |
|---|---|
| Pin A | Signal Non-Inverting |
| Pin B | Guard |
| Pin C | Signal Inverting |

Output Connector

| | |
|---|---|
| Pin A | Channel 2 Output |
| Pin C | Output Common Channel 2 |
| Pin D | Connector Shell |
| Pin E | Output Common Channel 1 |
| Pin G | Channel 1 Output |

Figure 2-3 2802-2 Enclosure Wiring

## 2.4 INITIAL CHECKOUT PROCEDURES

The amplifier is accurately adjusted and carefully inspected at the factory. The following tests check basic characteristics of the amplifier to verify proper operation upon delivery. The type of damage that can be expected in shipment tends to produce gross malfunctions rather than minor changes in sensitive characteristics. More complete and precise tests and calibration procedures are included in Section 5, "Calibration".

Only three items of test equipment are required to perform initial checkout of the amplifier:

- Audio Oscillator
- Voltage Divider/Attenuator
- Oscilloscope

Standard laboratory-type instruments from any manufacturer may be used.

### 2.4.1 Gain Checkout

1. Connect the common or ground terminals of each item of test equipment to a single point and to the amplifier output common (pin 1 of P2). Connect this point to ground. Make all measurements relative to this point (see Figure 2.4).

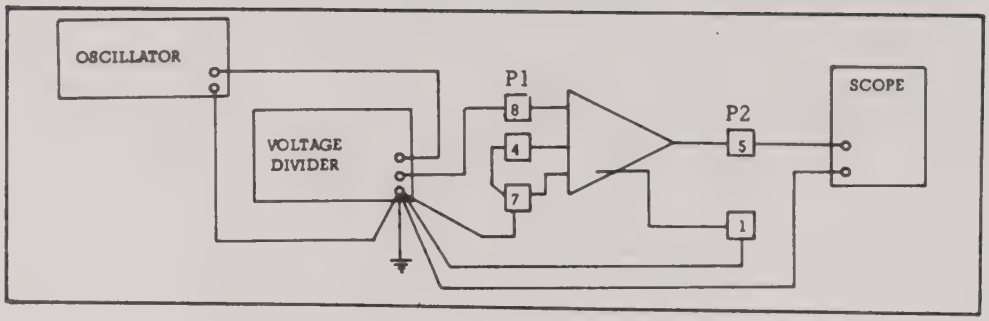



Figure 2.4 - Gain Test Setup.

2. Set voltage divider to minimum output — zero, if possible.

3. Apply power to amplifier. Observe amplifier output on oscilloscope. It should be within a few millivolts of ground and change only very slightly as the amplifier GAIN switch is rotated.

4. Set the VERNIER gain adjustment fully counterclockwise.

5. Set the GAIN selector switch at the highest gain position. If the amplifier is equipped with a Gain Multiplier switch (V2), set it to X 1.0.

6. Remove scope lead from amplifier output and connect scope to the oscillator output. Adjust oscillator for 20 volts, peak-to-peak, at 100 Hz.

7. Set voltage divider to the reciprocal of the maximum gain setting, 1/K. (For example, at maximum gain of 1000, set divider to 0.001.)

8. Return the scope to the amplifier output, pin 5 of P2. The scope should now indicate approximately the same value, 20 volts peak-to-peak, observed at the oscillator output. (The term "approximately" is used because of the limited capability of an oscilloscope to compare two magnitudes accurately.)

9. Verify that there is no obvious noise or other unexplained distortions on the oscilloscope trace.

### 2.4.2 Frequency Response Checkout

1. Use test setup exactly as connected for Gain checkout. Set amplifier GAIN control at maximum; vernier adjustment to minimum. Connect scope to oscillator output; set oscillator frequency to 20 kHz (gains 20 to 1000; 10kHz for gains below 20 or above 1000).

2. Set oscillator output at 20 volts, peak-to-peak (on scope).

3. Remove scope lead from oscillator and connect to amplifier output pin 5 of P2. Adjust voltage divider for amplifier output amplitude equal to that observed in step 2.

4. Compare voltage divider setting with zero — or minimum output position. The difference should be no less than 3dB, or approximately 30%.

### 2.4.3 Common Mode Rejection

1. Short the amplifier input leads and the input guard lead (pins 8, 4, and 7 of P1).

2. Connect oscilloscope to amplifier output (pin 5 of P2).

3. Set oscillator output to 20 volts, peak-to-peak, at 60 Hz.

4. Set amplifier GAIN switch to 1000.

5. Observe amplifier output on scope. The output due to common mode is normally not detectable above the wideband noise of the amplifier. Common mode rejection can be calculated as follows:

$$\text{CMR} = \frac{\text{20 Volts (P-P)} \times K}{\text{Output Voltage (P-P)}}$$

Common mode rejection may be measured more closely by following the procedures of paragraph 5.3.1, Section 5.

$$\text{CMR in dB} = 20 \text{ Log } \frac{\text{20 Volts (P-P)} \times K}{\text{Output Voltage (P-P)}}$$

$$\text{Example: CMR in dB} = 20 \text{ Log } \frac{\text{20 Volts (P-P)} \times K \text{ (1000)}}{\text{Output Voltage 20 Mv (P-P)}}$$

$$= \frac{20V \cdot 1 \cdot 10^{3}}{20 \text{ MV} \cdot 10^{-3}} = \frac{1V \cdot 10^{6}}{1} = 20 \text{ Log of } 1 \cdot 10^{6}$$

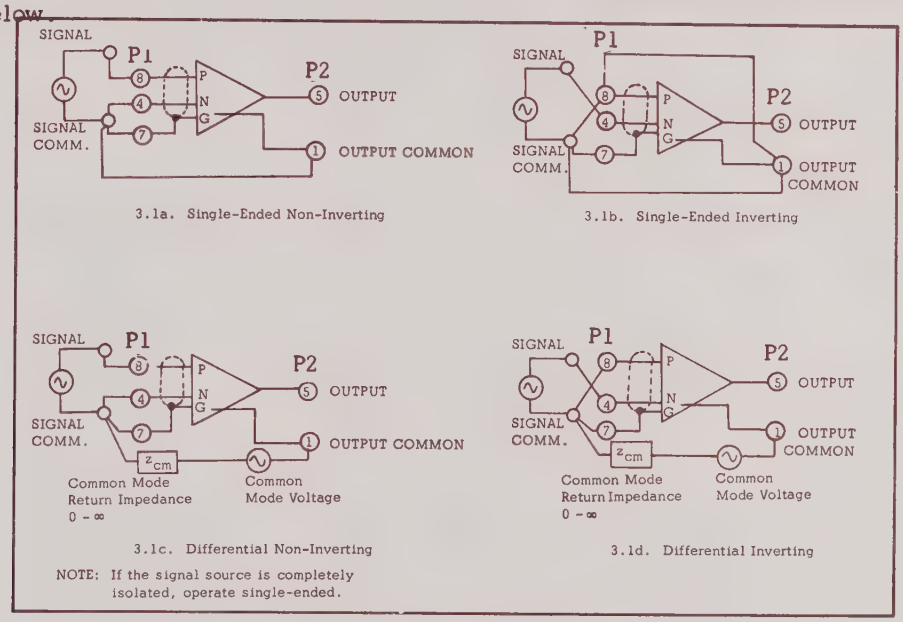
$$\text{CMR} = 120 \text{ dB}$$

# SECTION 3

# OPERATION

## 3.1 MODES OF OPERATION

The Dana Amplifier can be used in any of the four operating modes illustrated below.




3.1a. Single-Ended Non-Inverting

3.1b. Single-Ended Inverting

3.1c. Differential Non-Inverting

3.1d. Differential Inverting

NOTE: If the signal source is completely isolated, operate single-ended.

Figure 3.1 - Modes of Operation

## 3.2 CONTROLS

### 3.2.1 Gain Selector Switch

The GAIN switch is rotated to select the desired gain of the amplifier. The gains which can be selected vary with the options specified. Gain positions are tabulated below.

| Options | Gain Switch Positions |
|---|---|
| V1 & V2 | 20, 50, 100, 200, 500, and 1000 |
| V3 | 100, 200, 500, 1000, 2000, and 5000 |

### 3.2.2 Multiplier Switch (Option V2)

The Multiplier Switch is mounted concentrically with the GAIN selector switch. It has two positions, X.01 and X1. In X.01 position, it reduces the gain selected by a factor of 100. For example, effective gains would be 0.2, 0.5, 1,2,5 and 10. In the X1 position, amplifier gain is exactly as inscribed on the switch.

### 3.2.3 BANDWIDTH Switch

The BANDWIDTH switch allows selection of the amplifier bandwidth. It is calibrated in kilohertz and has the following positions:

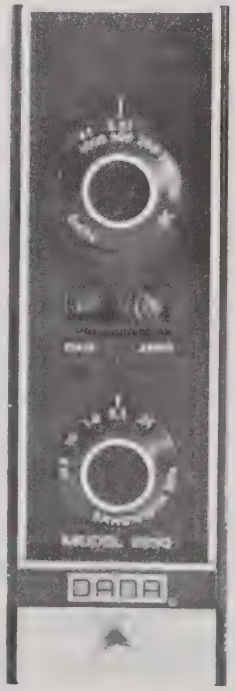
| Switch Position | Bandwidth |
|---|---|
| 0.01 | dc to 10 Hz - 3 dB |
| 0.1 | dc to 100 Hz - 3 dB |
| 1.0 | dc to 1000 Hz - 3 dB |
| 10. | dc to 10 kHz - 3 dB |
| Wideband (WB) | Full Bandwidth |

## 3.3 OPERATIONAL ADJUSTMENTS

### 3.3.1 ZERO Adjustment

ZERO is a screwdriver adjustment on the front panel of the amplifier. It is used to set the output voltage to zero volts with no input. It is adjusted in the following manner:

1. Apply power to the amplifier and any adjoining heat-producing equipment and allow amplifier to stabilize (approximately 30 minutes).
2. Set GAIN selector switch to lowest gain position.
3. Return the input P(P1-8) and N(P1-4) leads to output common (P2-1).
4. Connect voltmeter or scope to amplifier output (P2-5) and common (P2-1).
5. Adjust ZERO for zero amplifier output. Counterclockwise rotation corrects for a positive output; clockwise rotation corrects for a negative output.



2850 - V2

### 3.3.2 GAIN Adjustment

This is a screwdriver adjustment which serves as a vernier adjustment of gain selected by the GAIN selector switch. The adjustment varies each gain position by a factor of 2.5:1 — providing continuous gain selection throughout all available ranges.

## 3.4 OPERATING PROCEDURES

After installation of the amplifier as described in Section 2, operation consists simply of selecting the appropriate gain. The amplifier is ready for use immediately with zero stability achieved within 30 minutes.

## SECTION 4

## CIRCUIT DESCRIPTION

### 4.1 INTRODUCTION

This section contains an electrical description of each circuit in the amplifier. A block diagram of the Model 2850 is shown in Figure 4.1.

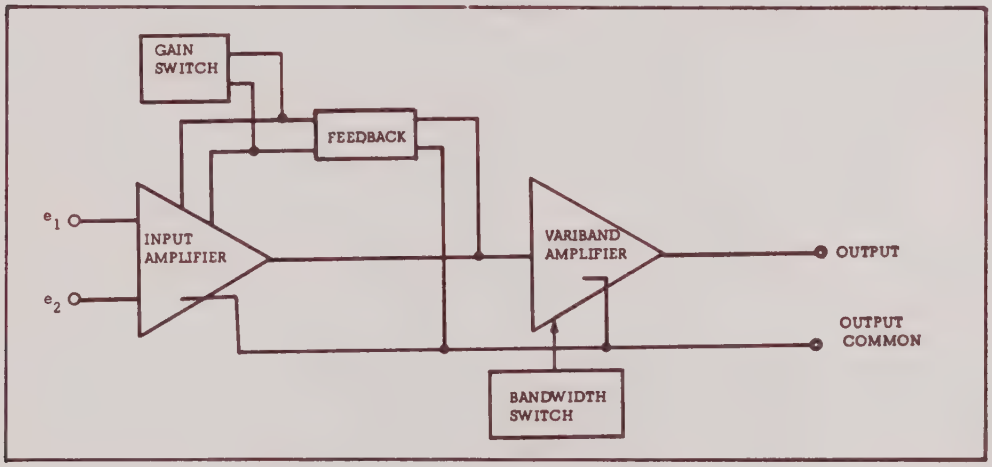



Figure 4.1 - Block Diagram

The forward loop consists of the Input Amplifier and the Output Amplifier. The loop is closed by the feedback network. The Input Amplifier amplifies the potential difference between the two inputs. When one input goes positive and the other input goes negative with respect to common, the output of the amplifier is proportional to the difference of the amplitudes. These signals are referred to "normal mode signal" (also referred to as "difference" or differential signals). The potentials common to both inputs are referred to as "common mode signals" and are rejected by the amplifier. The normal mode signals and the common mode signals are defined on the following page.

Normal Mode Signal $= e_1 - e_2$

Output ($E_O$) $= (e_1 - e_2)$ (Gain)

Common Mode Signal $= \frac{e_1 + e_2}{2}$

In single ended operation, a signal is applied to one input while the other input is common; therefore, the output is proportional to the amplitude of the one signal applied.

Figure 4.2 shows the amplifier responding to normal mode signals and rejecting the common mode signal (one-half) of the bridge supply voltage. In practical applications, there would be additional common mode potentials due to stray fields and other causes. These potentials, represented by "$e_x$", are also rejected.

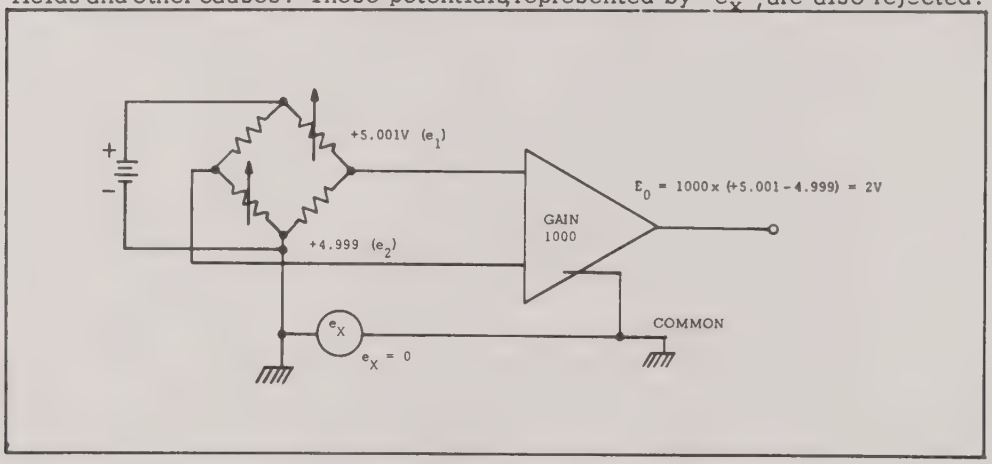



Figure 4.2 - Normal and Common Mode Response

## 4.2 NORMAL MODE AMPLIFIER

Figure 4.3 shows a potentiometric amplifier. This type of amplifier is a potentiometric device, since the feedback achieves a high effective input impedance by the same principle as the common "null balance" approach to precision measurements. In both cases, the effective input impedance approaches infinity at null. In the potentiometric amplifier, impedance is limited by factors such as leakage and practical values of loop gain.

Examining the feedback system, it can be seen that the feedback is of proper phase to cancel the effect of the input signal; however, the cancellation leaves a small "error" signal of sufficient magnitude to support the 5-volt output. In the example, if the open loop gain (gain without feedback) of the circuit were

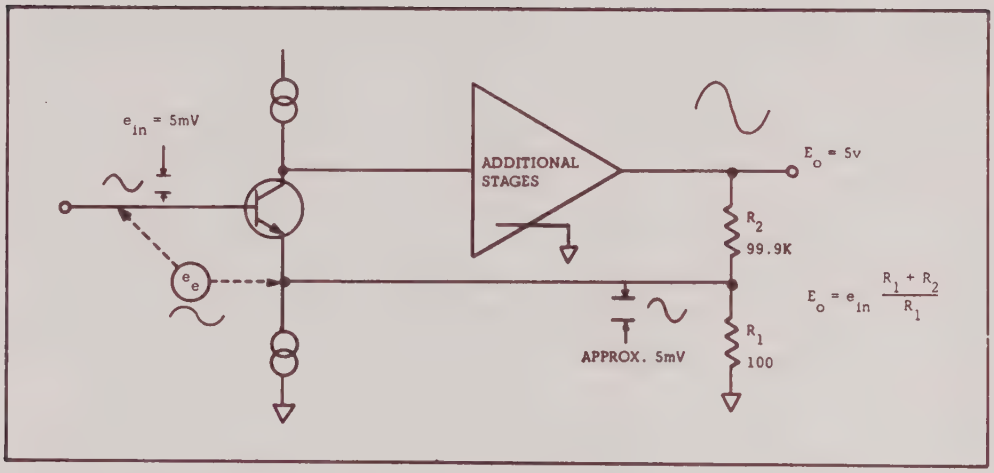



Figure 4.3 - Simplified Potentiometric Amplifier (Gain of 1000)

140 dB, the approximate residual error signal would be $5V/10^7$ or 0.5uV ($e_e$ in the figure).

To achieve the desired gain stability and linearity, the open loop gain is considerably greater than the closed loop gain. By keeping this ratio sufficiently high, the "closed loop" or "net gain" is essentially determined by the feedback elements alone.

Figure 4.4 shows two potentiometric amplifiers connected in a differential configuration. One-half of the normal mode voltage ($e_{NM}/2$) appears at $e_1$ while the other one-half of the normal mode voltage appears at $e_2$. As in Figure 4.3, a 5 millivolt signal at each of $e_1$ and $e_2$ will be 5 volts output at each potentiometric amplifier. With the differential amplifier stage as shown in Figure 4.5, the outputs of the balanced differential stages are combined in the summing amplifier which transfers one directly and inverts the other. This is in keeping with the normal mode signal characteristics of $e_1 - e_2$. Signals of common polarity or phase will cancel at the summing stage, the degree of cancellation dependent on their relative magnitudes.

Input lines ($e_1$, $e_2$) are connected to the bases of a pair of matched silicon transistors (dual transistors in a single case) and circuit parameters are adjusted to obtain equal characteristics in each stage. A unique aspect of the circuit is the technique employed in controlling these parameters for stable operation over wide temperature ranges.

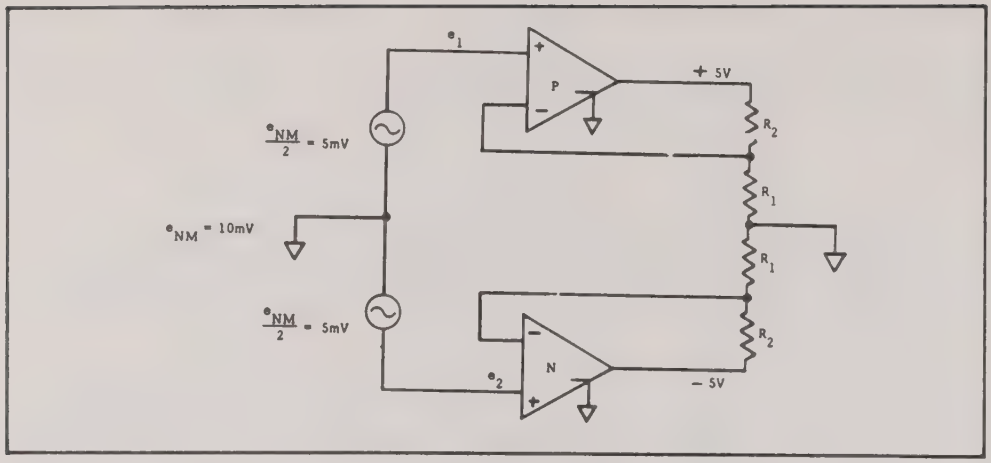



Figure 4.4 - Potentiometric Amplifiers in Differential Configuration

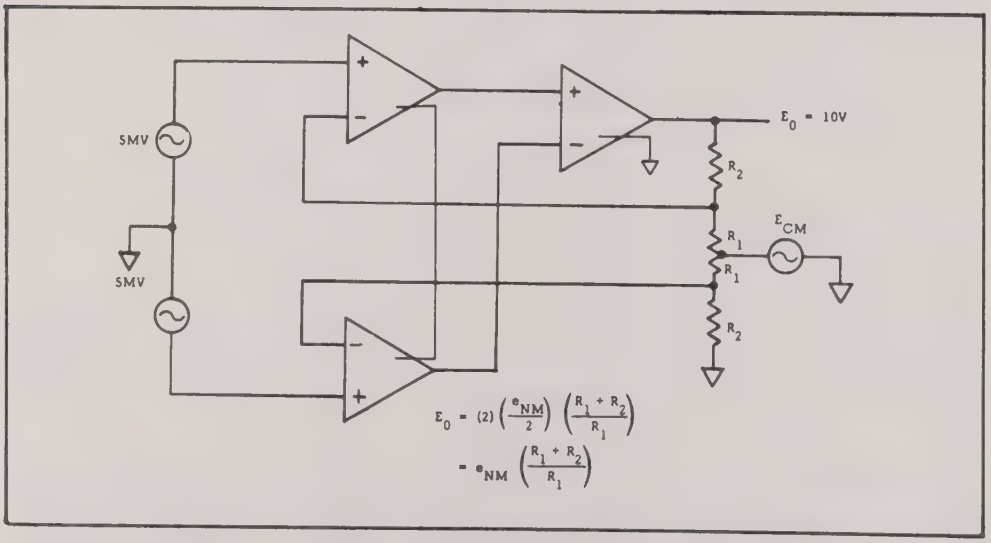



Figure 4.5 - Differential Stage for Summation of Inputs

## 4.3 COMMON MODE AMPLIFIER

Although the Normal Mode Amplifier provides a degree of common mode rejection (CMR = 60 to 70 dB with balanced source), it is insufficient for high accuracy data systems. The primary deficiency of the circuit is the low impedance between the input lines and common - too low to materially reduce common mode currents. This deficiency is overcome by the use of a separate Common Mode Amplifier

(CMA) which senses the common mode voltage at the input and forces the emitters of the "input pair" of the normal mode amplifier to the same potential (neglecting bias). This "bucking" voltage allows very little current to flow from either input to output common, increasing the intrinsic impedance to common.

Figure 4.6 shows the relationships of the normal mode amplifier and the common mode amplifier. The output of the common mode amplifier ($E_{CM}$) is connected to the junction of the $R_1$ resistors.

The voltages, $e_1$ and $e_2$, appear at the voltage divider as shown in Figure 4.6. The "bucking" voltage is supplied by the common mode amplifier.

Consider the upper-half of the voltage divider and the lower-half of the voltage divider as shown in Figure 4.7. The upper-half of the voltage divider is bounded by the two voltages $E_O$ and $E_{CM}$. The voltage at $E_{01}$ is equal to

$$E_{01} = E_O - \left(E_O - E_{CM}\right)\left(\frac{R_2}{R_2 + R_1}\right)$$

and is the "bucking" voltage to effectively cancel $e_{CM} + \frac{e_{NM}}{2}$.

The lower-half of the voltage divider is bounded by $E_{CM}$ and common. The voltage at $E_{02}$ is equal to

$$E_{02} = E_{CM}\left(\frac{R_2}{R_1 + R_2}\right)$$

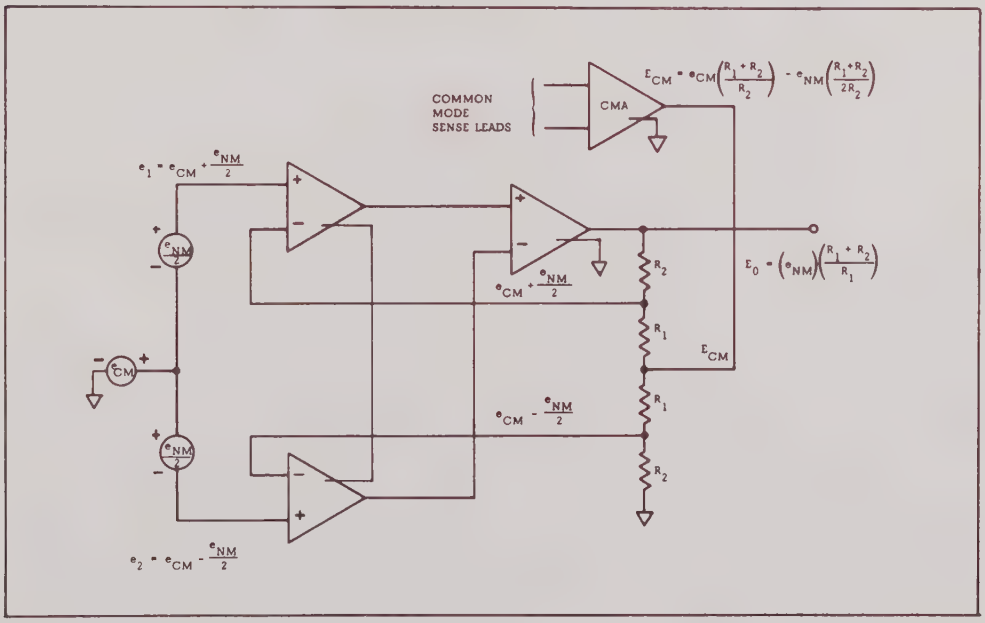



Figure 4.6 - Normal Mode Amplifier and Common Mode Amplifier

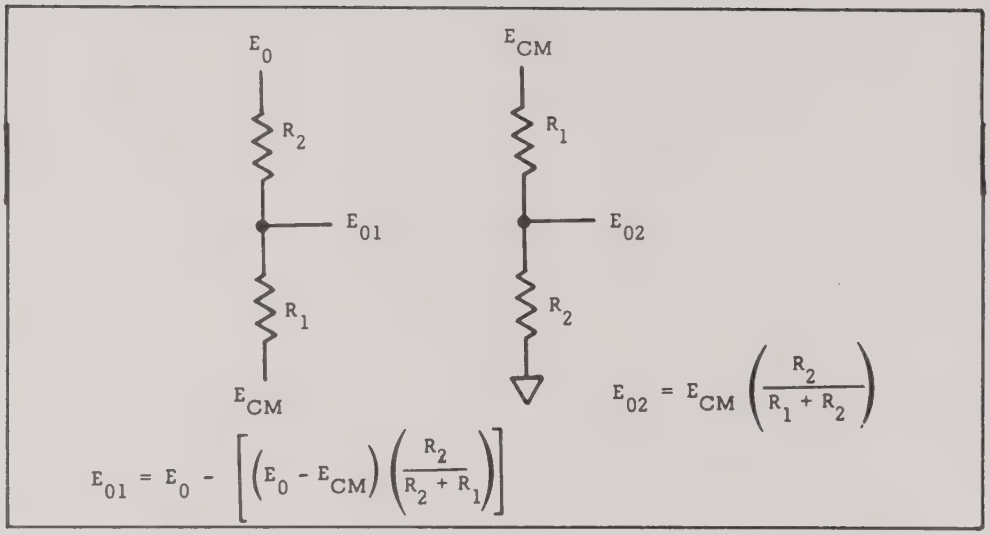



Figure 4.7 - Voltage Dividers

and is the "bucking" voltage to effectively cancel

$$e_{CM} - \frac{e_{NM}}{2}$$

The common mode voltage ($E_{CM}$) from the common mode amplifier required to satisfy the above equations is

$$E_{CM} = e_{CM}\left(\frac{R_1 + R_2}{R_2}\right) - e_{NM}\left(\frac{R_1 + R_2}{2R_2}\right)$$

The gain of the normal mode amplifier is set by inserting a resistor $R_X$ as shown in Figure 4.8. Resistor $R_X$ does not influence the value of $E_{CM}$ and may be varied without interfering with the common mode compensation.

### 4.4 INPUT AMPLIFIER

The Input Amplifier can now be shown as in Figure 4.9a. Differential input signals cause out-of-phase signals to be developed across the input pair's respective collector resistors. Under these conditions, the drop across the collector summing resistor (R36 in Figure 4.9a) remains constant; however, a voltage source common to both input lines ($e_{CM}$) causes in-phase collector current variations which add through R36 and produce a signal proportional to the common mode potential, providing an input to the CMA. As illustrated in Figure 4.9a, the CMA couples a feedback signal to the emitters of the input pair

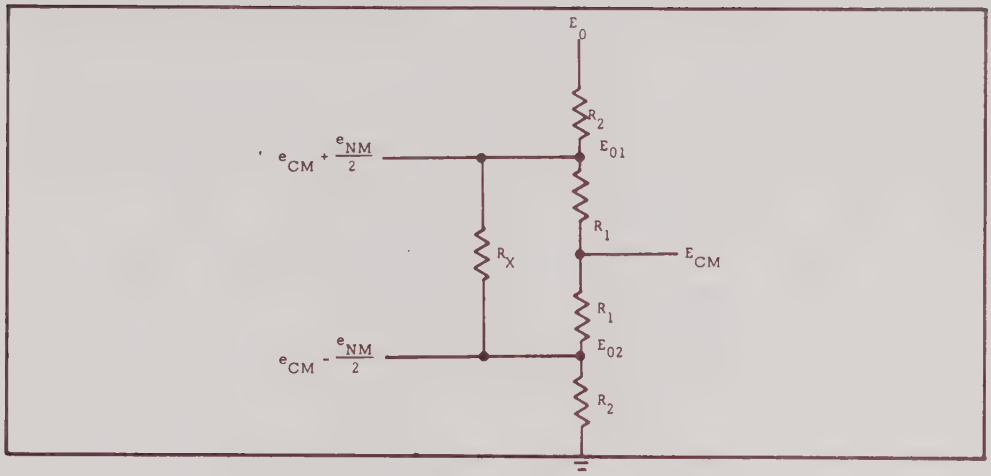



Figure 4.8 - Gain Set

through R42 and R44. This signal is of the proper phase to cancel the effect of the input potential and maintain the sum of the two collector currents constant. Cancellation is complete except for a small residual error voltage necessary to maintain the output of the CMA very near the common mode potential (ignoring attenuator insertion loss).

For convenience, the Common Mode Amplifier (CMA) has been described as if it were a single-ended device referenced to ground. However, the CMA is a differential amplifier much like the Normal Mode Amplifier and, as such, responds to the difference between its input terminals. In the actual circuit, one of the CMA input terminals is connected to the lower side of the input stage collector summing resistor and the other to a passive divider connected between the input pair emitters and the top of the collector summing resistor (Figure 4.9a).

If this circuit is closely examined, it can be seen that the various circuit elements form a simple bridge. This identity is established in Figure 4.9b. In operation, the application of a common potential to the input transistors tends to unbalance the bridge by changing the conductance of the input pair. This effect is opposed by driving the lower end of the bridge (or the emitters of the input pair) with the output of the CMA. This feedback effectively cancels the change in conductance and restores the bridge to balance.

As previously stated, the parameters of the input stage are carefully adjusted for nearly identical characteristics. Once established, they cannot be allowed to change when the circuit is subjected to common mode potentials. From Figure 4.9 it can be seen that the entire input circuit is floating between two

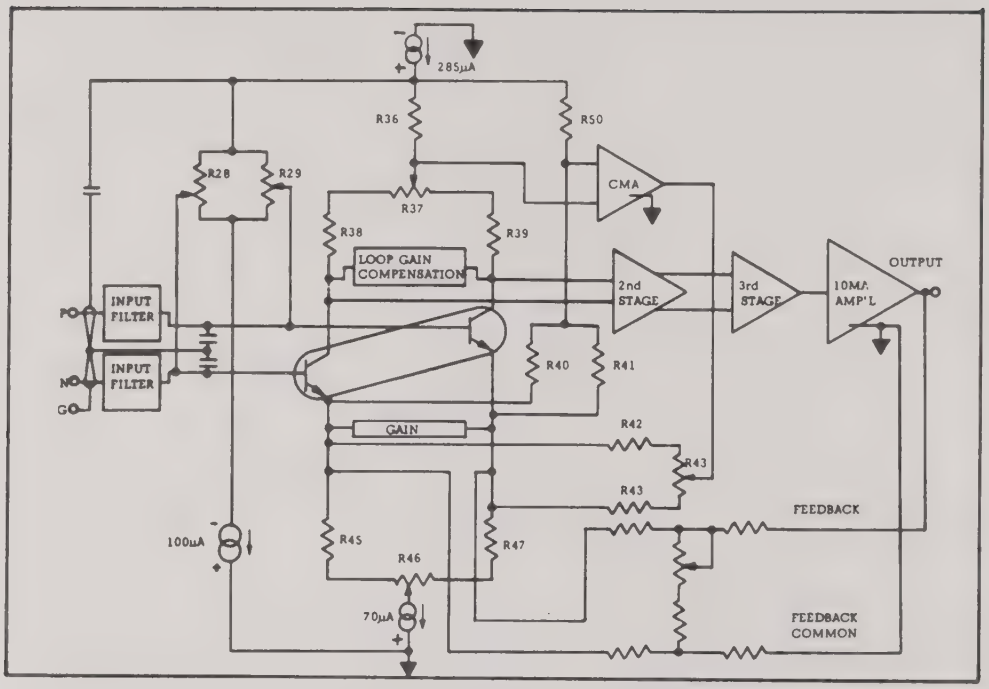



Figure 4.9a - Input Amplifier

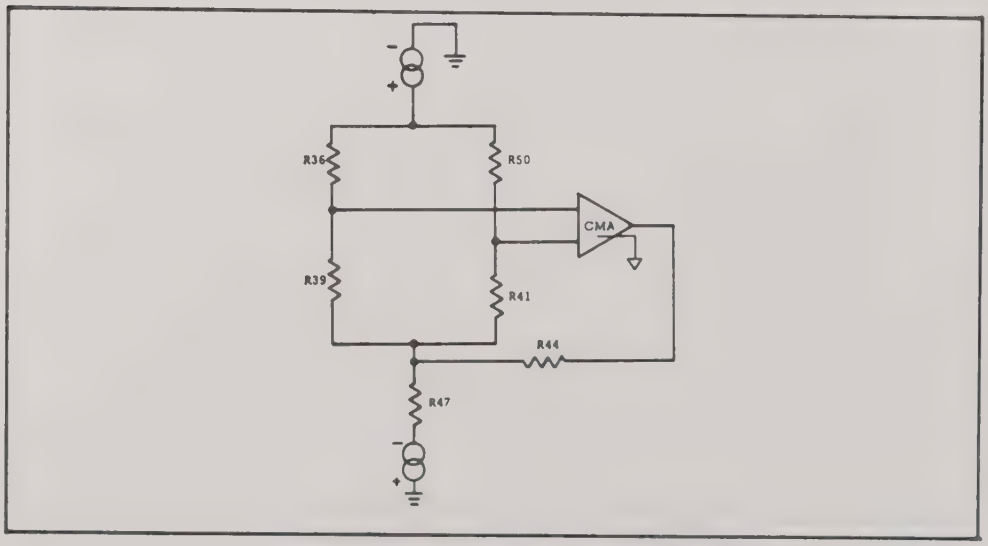



Figure 4.9b - Equivalent Bridge

constant current generators. Since it has been established that the active elements in the bridge circuit (transistors) are continuously balanced against passive elements (R36, R39, R50, R41), it becomes apparent that the constant current sources will also serve to maintain constant voltage conditions across the bridge (constant I x constant R = constant E). This means that, as the lower part of the bridge is driven up and down synchronously with the common mode potentials, the voltage at the top of the bridge varies with the same relative magnitude. This "bootstrapping" effect raises the intrinsic common mode rejection of the input pair to the high values required for high accuracy systems.

Potentiometers R28 and R29 are the N-input and P-input offset-current zero adjustments to minimize the current flow-through the input terminals.

The gain and loop-gain compensation blocks shown in Figure 4.9 are networks selected from the front panel GAIN select switch.

## 4.5 VARIBAND OUTPUT AMPLIFIER

The VARIBAND OUTPUT AMPLIFIER (Figure 4.10) consists of a single ended amplifier and an active admittance filter. The single ended amplifier is a unity gain, complementary symmetry class AB power amplifier capable of delivering 100 milliamperes into a 100 ohm load; output voltage is 10 volts peak, 20 volts peak-to-peak.

A separate power supply provides a positive voltage and a negative voltage capable of delivering up to 100 milliamperes to the load. The power supply is shown as batteries in Figure 4.11. The current supplies are controlled by common-emitter transistor drivers and are switched to common in accordance with the input signal. Transistor Q36 controls the positive current through the load. As the positive current increases through the load, the output voltage at the common connection node of the current supplies goes negative. As the negative current increases through the load (controlled by transistor Q38), the output voltage goes positive.

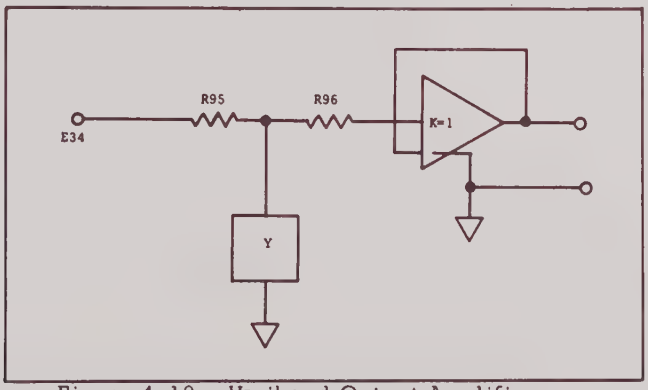



Figure 4.10 - Variband Output Amplifier

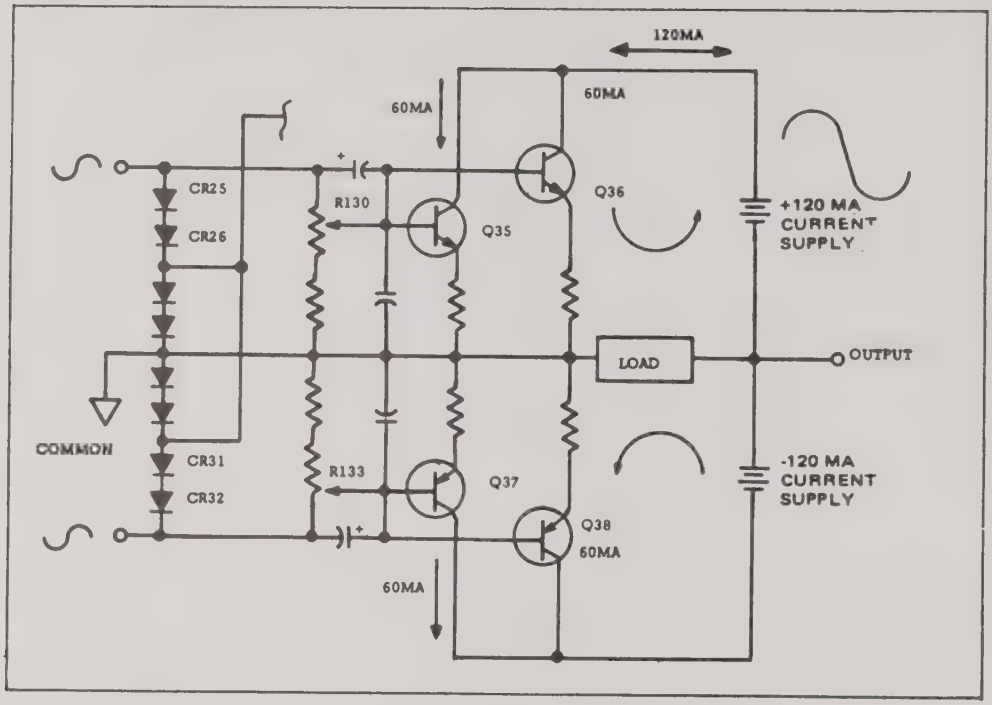



Figure 4.11 - Output Drivers and Current Limiters

The negative current limit is determined by adjusting R130 (500 ohm potentiometer), the positive current limit is determined by adjusting R133 (500 ohm potentiometer). The current adjustment for each potentiometer is approximately 95-150 milliamperes. Diode clamps CR25 and CR26 will conduct when the voltage across either the emitter resistor of the output driver (Q36) or the emitter resistor of the current limiter (Q35) reaches +0.6 volts. Diode clamps CR31 and CR32 will conduct when the voltage across either the emitter resistor of the output driver (Q38) or the emitter resistor of the current limiter (Q37) reaches -0.6 volt.

The short-circuit current limit of the Output Amplifier is approximately 150 milliamperes; the current limit for a 100 ohm load is approximately 120 milliamperes. The Active Admittance Filter (Figure 4.12) consists of a passive RC network and an operational amplifier. The passive network is a 3-pole Bessel filter. The network is driven by an operational amplifier and attenuates the signal by 6dB $\pm$1dB at the cutoff frequency ($f_{CO}$); attenuation above the cutoff frequency is 18dB per octave, 60dB per decade. One of five bandwidths is selected from the front panel BANDWIDTH switch that selects the capacitors in the passive network.

## 4.6 FEEDBACK CIRCUIT

The differential input of the amplifier requires a feedback network slightly more complex than the simple divider that was shown in Figure 4.3. To illustrate, consider the case where one input is connected to a positive signal and the other to a negative signal. It would appear that the proper bipolar feedback for both inputs could not be derived from a single output terminal; however, this is not the case.

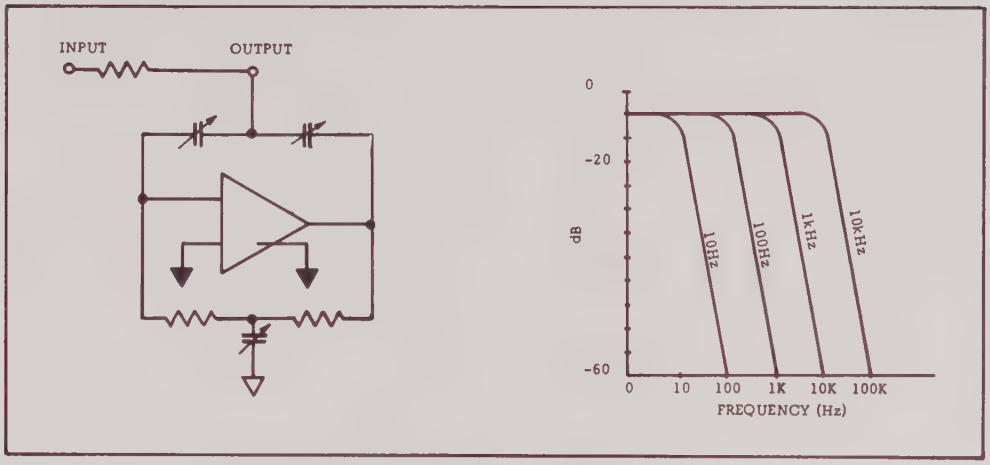



Figure 4.12 - Active Admittance Filter

Figure 4.13 shows the equivalent feedback network of the amplifier. For the purpose of the initial discussion, assume no connection between points A and B, and that the amplifier has somehow arrived at the proper ten-volt output for a ten-millivolt input (gain of 1000). It can be seen that the voltage difference between the two feedback lines is the required 10 millivolts; however, both lines are approximately +5 volts above common. This is obviously intolerable and the circuit will not function until a connection is made between points A and B. It should be emphasized that the +5 volts is common to both input transistors and would tend to unbalance the common mode bridge just as an external common mode potential would do. The only difference in the two situations is the fact that the "feedback" common mode voltage is internally generated and tends to drive the input emitters in lieu of the bases. The latter results in one less phase inversion for internally generated common mode signals, producing an output from the CMA of the opposite output which goes negative until the feedback lines become approximately +5 millivolts and -5 millivolts with respect to common.

It can now be seen that the CMA will not tolerate the bridge to be unbalanced at any time, whether the common mode potential is introduced internally or externally. More specifically, the collector currents are never permitted to shift in the same direction but can only vary by equal and opposite amounts in response to differential input signals. This fact holds true regardless of the symmetry of the input signals. For example, consider the situation where one input is tied to common and the other is driven with a 10 millivolt AC signal. The CMA assumes the proper signal level so that equal and opposite error signals exist between the base and emitter of each input transistor. The final quiescent conditions are shown in Figure 4.14.

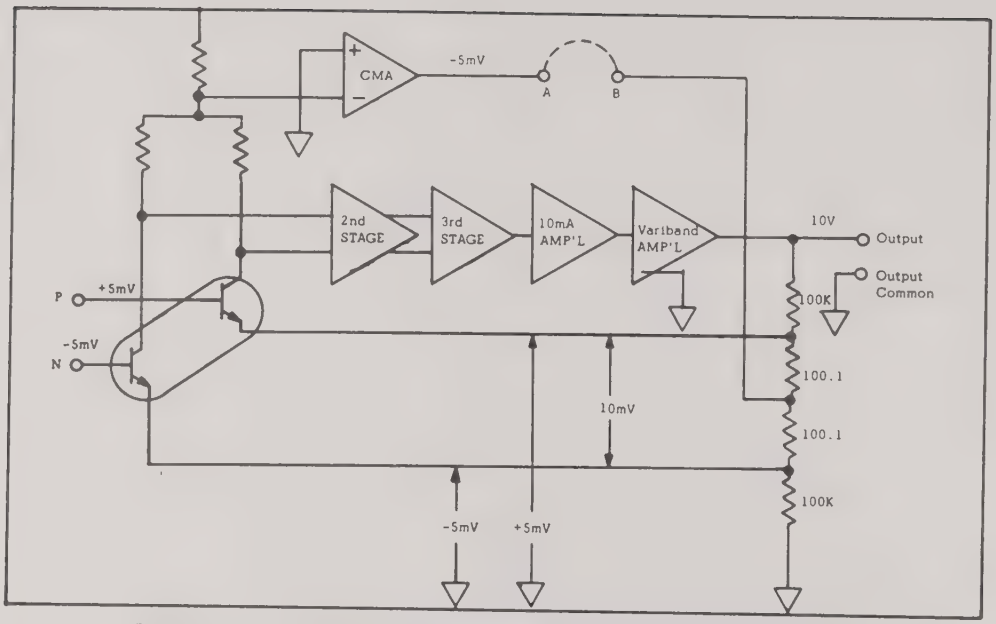



Figure 4.13 - Equivalent Feedback Network for Gain of 1000

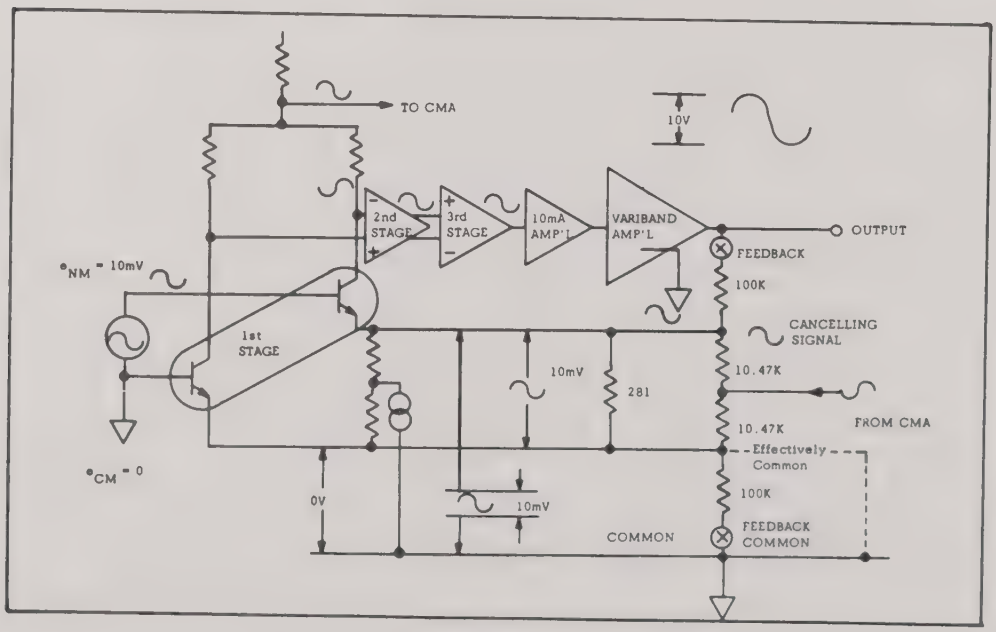



Figure 4.14 - Forced Internal Symmetry

## 4.7 ADDITIONAL CIRCUIT DETAILS

For ease of explanation, several circuit details were intentionally overlooked. Specifically, the diagrams used to illustrate certain fundamental points inferred a quiescent voltage level of zero at several points that are normally several volts positive or negative with respect to ground. Circuit operation as described is fundamentally accurate except that signal levels are relative to the initial conditions. The static bias condition of the input pair is of particular interest since it is related to input current uncertainty. These stages are initially forward biased and, though the base idling currents are quite low, they would develop an offset voltage if allowed to flow through the external signal source resistance.

To minimize this effect, each input line is connected to a source that shunts this current to the amplifier's internal supplies. An adjustment is provided for each input line, permitting the input current to be periodically rezeroed in the field (R28, R29 in Figure 4.9). To prevent common mode loading, these sources are floated between a constant current generator and the top of the common mode bridge. Since both input leads and the collector supply move together with the common mode potential, the current through the base resistors remains very nearly constant. This infers that the impedance to common potentials is a large magnification of the apparent 5 megohms in each base lead (on the order of 1000 megohms); and also points out that the quiescent base current is virtually undisturbed by common mode potentials.

Another important point is the relationship between the magnitude of the common mode potential and the voltage level at the output of the CMA. If the source of common mode is external, the output of the CMA is 10% greater than the applied voltage; if the source is internal (one-half of the output signal), the output of the CMA is $-E_{out}/20$. This relationship is solely determined by the ratio of the respective feedback resistors.

# SECTION 5

# CALIBRATION

## 5.1 TEST EQUIPMENT

(a) OSCILLOSCOPE - Identical X & Y inputs; bandpass, DC-500 kHz; calibrated deflection factors of 1 millivolt to 20 volts per centimeter accurate within 3%; input impedance, 1 megohm paralleled by less than 50 pF.

(b) OSCILLATOR - Frequency range, 5 Hz - 500 kHz; accuracy, ±2%; frequency response, ±1 dB; adjustable output voltage, 160 milliwatts (10 volts) into 600 ohms rated load, 20 volts open circuit.

(c) AC VACUUM TUBE VOLTMETER - Voltage range, 0.1 millivolt to 300 volts; dB range, -72 to +52 dB; frequency range, 10 Hz to 1 MHz accurate within ±2% (50 Hz - 500 kHz); input impedance, 10 megohms paralleled by less than 50 pF.

(d) ATTENUATOR - Attenuation to 120 dB in 1 dB steps; DC to 1 MHz accurate within ±1 dB; power capacity, 5 watts.

(e) DC MILLIVOLTMETER (Optional)

(f) Dana Model 2195 Test Panel (Optional) or Dana Cord Set Model 2801 (P/N 402468). The Dana Model 2195 Amplifier Test Panel provides a convenient means of testing and calibrating Dana amplifiers. The panel requires that only the amplifier, input, output and power inputs be connected with no further reconnections required. All input and output configurations necessary to calibrate or test the amplifier are set up by switches and controls mounted on the panel. The panel is shown in Figure 5.1.

A special adapter cable for 2800 to 2195 is required.

## 5.2 LISSAJOUS FIGURES FOR COMMON MODE ADJUSTMENTS

The output null of the amplifier is checked with the Lissajour figures shown in Figure 5.2. The adjustments for the quadrature error and amplitude error are mentioned in paragraph 5.3.1. Figure 5.2a shows the amplifier output at null for maximum common mode rejection.

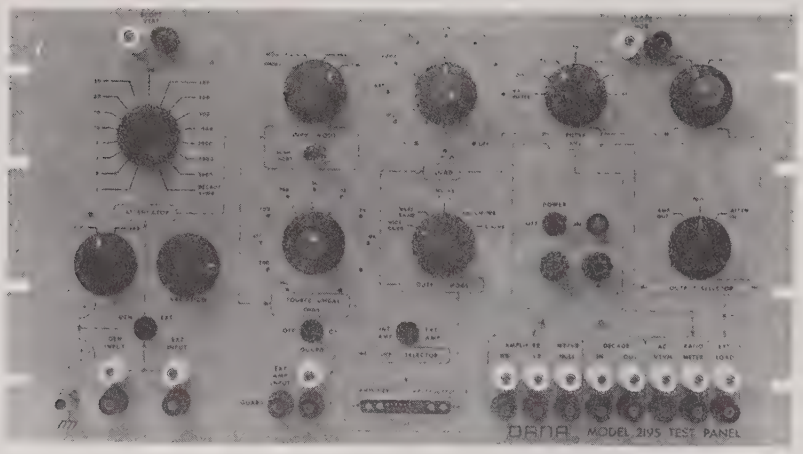



Figure 5.1 - Model 2195 Amplifier Test Panel

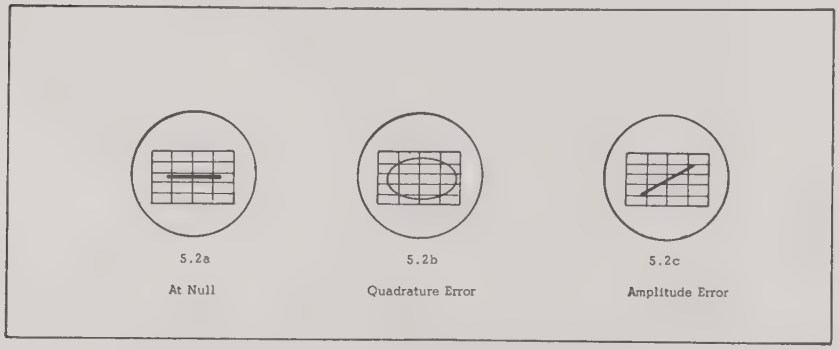



Figure 5.2 - Lissajous Figures

## 5.3 CALIBRATION PROCEDURES

In addition to the following calibration procedures, certain performance characteristics should be checked periodically and internal adjustments made as required. These measurements are described in Section 5.4. The procedure below should be performed in the order listed.

### 5.3.1 Common Mode Adjustment

NOTE: Common mode potentials appear between the guard box and chassis; therefore, an insulated screwdriver or adjustment tool (J.F.D. Adjustment Tool 5284) should be used to make the calibration adjustments of the input amplifier.

The amplifier has four controls that affect common mode rejection by adjusting the symmetry of the input circuit. R43 and R10 compensate for resistive unbalance. C5 and C15 adjusts the capacitive symmetry. Physical location of the four components is shown in Figure 5.3.

The V1 and V3 gain options quadrature error and amplitude error are adjusted by adjusting the following components:

Capacitor C15 - quadrature error
Potentiometer R43 - amplitude error

The V2 option has the above adjustments when the Multiplier switch is in the X1 position. Another set of adjustments calibrates the quadrature and amplitude error for the X.01 Multiplier switch position. These adjustments are:

Capacitor C5 - quadrature error
Potentiometer R10 - amplitude error

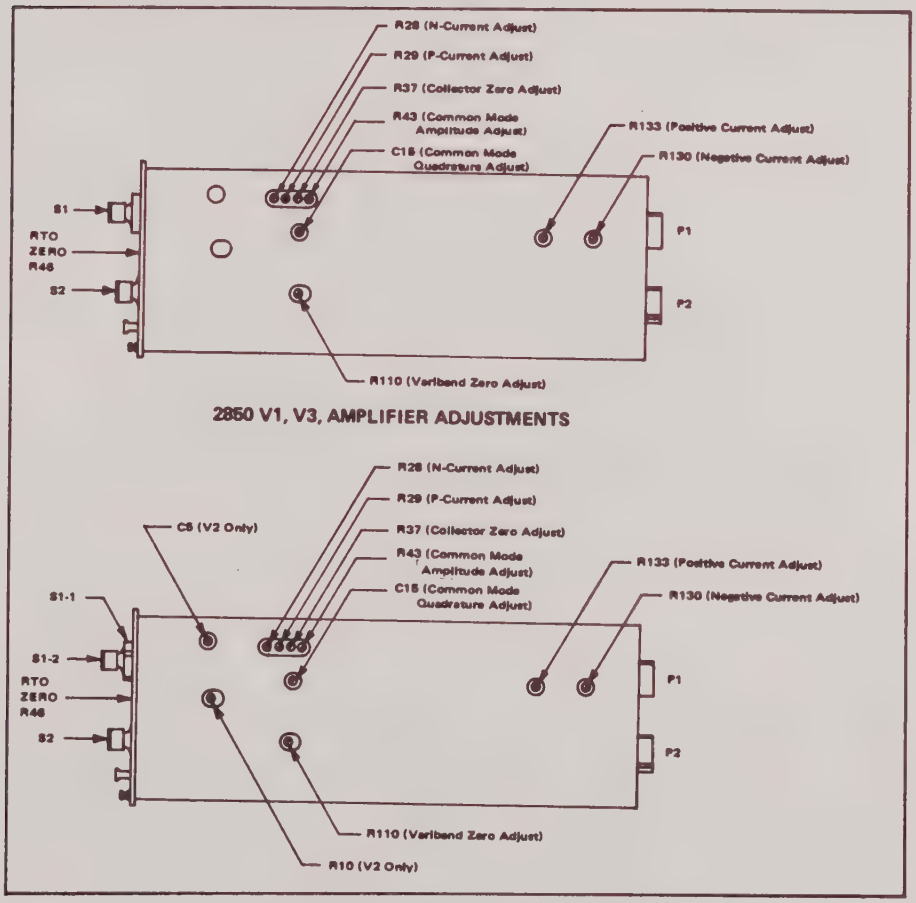



Figure 5.3 2850-Amplifier Adjustments

Common mode adjustment procedures are as follows:

(1) For V1 attenuator option:

(a) Connect inputs P(P1-8), N(P1-4), and guard (P1-7) to the high side of a signal generator, returning the low side to output common (P2-1).

(b) Connect the signal generator to the X-axis (horizontal) of an oscilloscope with the X-axis sensitivity set to 5 V/cm.

(c) Connect the amplifiers output (P2-5) to the Y-axis (vertical) of the oscilloscope through a single pole, low pass filter consisting of a 16K resistor and a 0.01 microfarad capacitor. Set the sensitivity of the Y-axis to 10 mV/cm. (See figure 5.4).

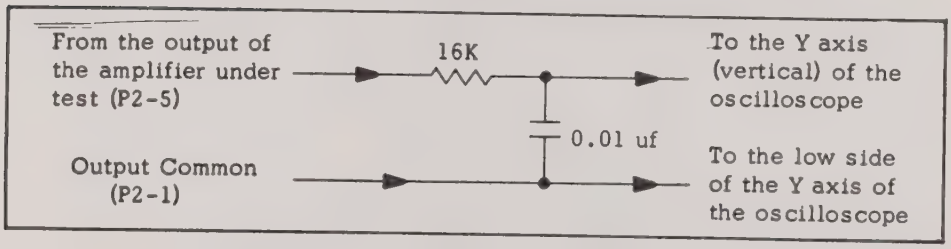

From the output of the amplifier under test (P2-5)
16K
To the Y axis (vertical) of the oscilloscope
0.01 uf
Output Common (P2-1)
To the low side of the Y axis of the oscilloscope

Figure 5.4 - Single-pole low pass filter

(d) Place the gain switch (S1) in the 1000 position, and the variband switch (S2) in the wideband position.

(e) Set the signal generator to 20 volts (P-P) at 60 Hz.

(f) Adjust the amplitude error potentiometer (R43) for minimum amplitude error as shown in figure 5.2c.

(g) Adjust the quadrature error trimmer (C15) for minimum quadrature error as shown in figure 5.2b.

(h) Adjust both R43 and C15 for a straight line as shown in figure 5.2a.

(2) For V2 attenuator option:

(a) Complete steps 5.3.1(1) (a) through (h) before continuing the Common Mode Adjustment for V2 attenuator option.

(b) Place the multiplier switch to the X.01 position.

(c) Adjust the amplitude error potentiometer (R10) for minimum amplitude error as shown in figure 5.2c.

(d) Adjust the quadrature error trimmer (C5) for minimum quadrature error as shown in figure 5.2b.

(e) Adjust both (R10) and (C5) for as near as possible a straight line as shown in figure 5.2a.

(3) For V3 attenuator option:

(a) For V3 attenuator option, complete steps, 5.3.1 (a) through (h). Be sure the gain switch (S1) is in the 1000 position, and not the 5000 position. All common mode adjustments and measurements are performed in the gain of 1000.

5.3.2 Collector Zero Adjustment (RTI)

In addition to the operational zero (RTO) adjustment on the front panel, the amplifier is equipped with an internal RTI collector zero adjustment (R37). Procedure for making the adjustment is as follows:

(a) Connect the amplifier inputs P(P1-8), N(P1-4), and guard (P1-7) to output common (P2-1).

(b) Connect an oscilloscope or millivoltmeter to output (P2-5) and common (P2-1).

(c) Set the amplifier gain switch to the gain position (20 for V1, V2 options; 100 for V3 option); set (V2 options only) the multiplier in the X1 position.

(d) Adjust the front panel RTO zero adjustment (R46) for minimum reading on the oscilloscope or millivoltmeter. Record any residual offset.

(e) Set the amplifier gain switch to the 1000 position for gain options V1, V2, and V3 option.

(f) Adjust the internal RTI collector zero adjustment (R37) for the same offset recorded in step (d).

(g) Repeat steps (d), (e) and (f) until the output remains the same on both the higher and the lowest gain positions.

(h) Set the multiplier switch (V2 options only) in the X.01 position.

(i) Set the gain switch to the 1000 position.

(j) Adjust the "N" current adjustment (R28) for the same offset recorded in step (d). The "N" current adjustment (R28) also adjusts the X01 multiplier RTI zero adjust.

### 5.3.3 Input Current Adjustment

This adjustment minimizes current flow through the input terminals.. For most accurate adjustment, the following procedures should be performed after the collector zero adjustment.

(a) Set the amplifier gain switch to the gain of 1000 for V1, V2, and V3 options. Set the multiplier switch (V2 option only) in the X1 position.

(b) Connect a 1K ohm resistor to the P input lead P(P1-8). Connect another 1K ohm resistor to the N input lead N(P1-4). Connect the two 1K ohm resistors and guard (P1-7) to output common (P2-1). (See Figure 5.5)

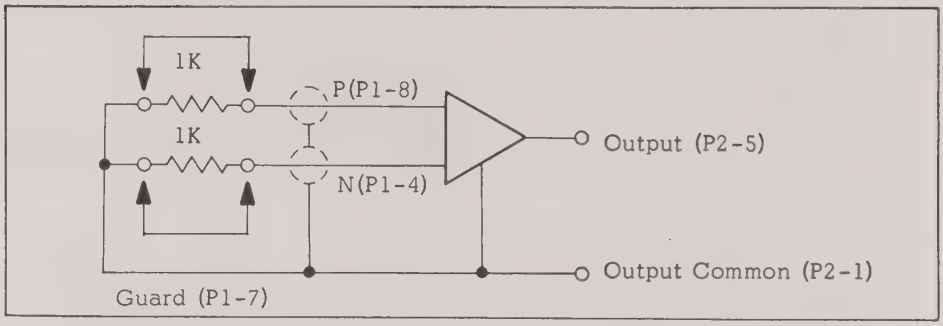



Figure 5.5 - Input Lead Connections

(c) Connect the oscilloscope to output (P2-5) and common (P2-1). Set the vertical deflection to 5 mV/cm.

(d) Short out the 1K ohm resistors in step 5.3.3b. Record the output offset as indicated by the oscilloscope. (See figure 5.5)

(e) Remove the short across the 1K ohm resistor in series with the N lead (P1-4). Adjust R28, the N current control for the same offset recorded in step 5.3.3d. Short out the 1K ohm resistor on the N lead.

(f) Adjust R37 RTI collector zero for the same offset as step 5.3.3d.

(g) Remove the short across the 1K ohm resistor in series with the P lead (P1-8). Adjust R29 P-current adjust; for the same offset as in step 5.3.3d. Short out the 1K ohm resistor on the N lead.

(h) Repeat step 5.3.3f.

(i) Repeat steps (e), (f) and (g) until there is no offset between the P or N leads with or without the 1K ohm resistors in series. All three voltages should be the same offset within 1 mv of each other.

(j) Set the multiplier switch (V2 only) to the X01 position. Adjust R28 N-current adjustment to the same offset as in step 5.3.3d.

### 5.3.4 Output Zero Adjustment

This adjustment sets the zero of the Output Amplifier by means of the ZERO adjustment on the front panel.

1. Connect input terminals N(P1-4) and P(P1-8) to output common (P2-1). Connect this point to ground.

2. Connect an oscilloscope across the output (P2-5) and common (P2-1).

3. Vary the ZERO adjustment (on front panel) for minimum reading on oscilloscope. Note this voltage for further reference. (This voltage represents residual offset).

### 5.3.5 Output Current Limit Adjustment

Although the output short circuit current is set at Dana for ± 150 ma, it may be desirable to limit the output current to a lesser value to afford the recording device protection. Potentiometers R91, 92, located on the printed circuit board, vary the output short circuit current from 60 ma to 150 ma. A voltage limit at the output of ± 13V DC or peak AC provides an additional degree of protection to the recording device.

To set the output current for 100 milliamperes, follow the steps below:

(1) Connect a 10 volt power supply, a 10 ohm 1/2 watt load resistor, and a DC voltmeter as shown in Figure 5.6. Connect battery as in position "A".

(2) Adjust R92 until the voltmeter reads 1.0 volts ± 10%.

(3) Connect the battery as in position "B".

(4) Adjust R91 until the voltmeter reads 1.0 volts ± 10%.

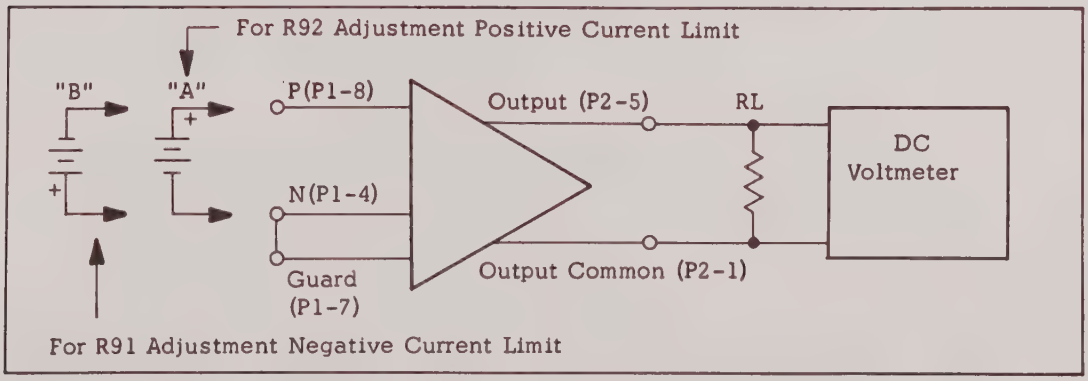



Figure 5.6 - Test Setup for Current Limits

## 5.4 TESTS OF AMPLIFIER CHARACTERISTICS

The following measurements check basic amplifier operating characteristics -- such as gain, bandpass, etc.

### 5.4.1 DC Gain Measurement

1. Connect test setup as shown in Figure 5.7. (The signal source need not be particularly accurate or stable, but the voltage divider must be extremely accurate. The null detector must be isolated and resolve less than 1 mV).
2. Set DC voltage source at 10 volts.
3. Adjust voltage divider so that there is no change in null detector indication when the input polarity is reversed by the reversing switch. Note ratio of voltage divider setting. Calculate gain as follows:

$$K = \frac{1}{h}$$

where K = amplifier gain
h = ratio of voltage output to input of divider.

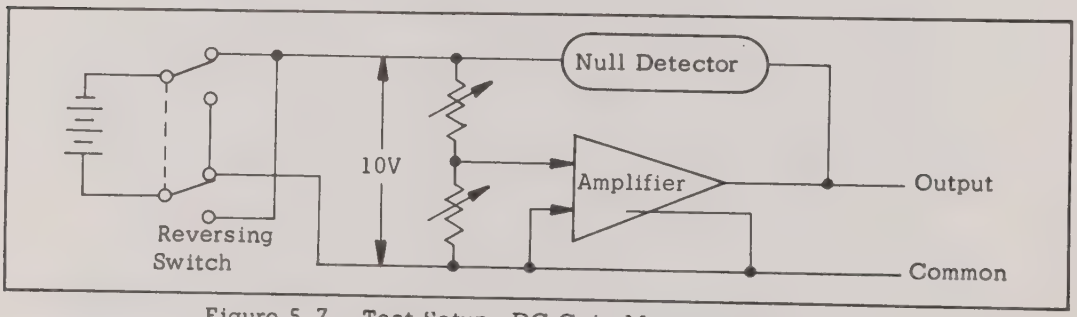



Figure 5.7 - Test Setup, DC Gain Measurement

### 5.4.2 Linearity Measurement

Ideally, gain should be independent of the magnitude of the output voltage from minus full scale to plus full scale. Since the Dana Amplifier's departure from this ideal is small, the null balance method of the gain measurement is again used. Linearity can be measured immediately after the DC gain measurement (see Figure 5.7). The test setup shall remain the same except that a variable DC voltage is required.

Steps 1 and 2 are followed as for DC gain Measurement (5.4.1). The input voltage is then varied from minus full scale to plus full scale, and the peak reading of the null detector recorded. The linearity in percentage can be calculated as follows:

$$\frac{\text{Peak Null Detector Reading (Volts)} \times 100}{\text{Full Scale (10 Volts)}}$$

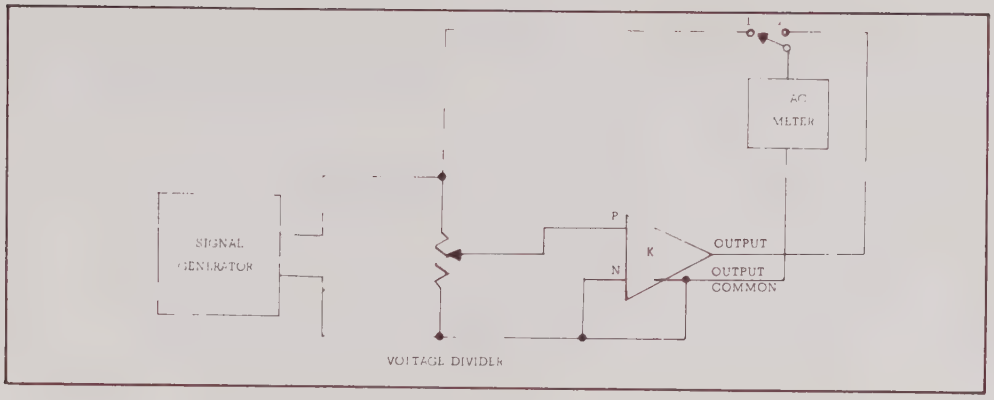



Figure 5.8 - Test Setup, AC Gain Measurement

### 5.4.3 AC Gain Measurement

The technique used for DC gain measurement can be extended to AC if the phase lag in the amplifier is compensated and a suitable null detector is used. If these types of measurements are anticipated, a special transformer and phase correction network may be procured from Dana; however, in general, a simpler and more direct method is described below:

1. Connect test setup as shown in Figure 5.8. (The divider should be of sufficiently low impedance to prevent errors due to source resistance. The output meter should be a good quality AC voltmeter having a mirrored scale and at least 100 minor divisions).

2. Place the monitor switch to position 1 and set the signal generator to an output of approximately 7 volts RMS at 60 Hz.

3. Select a minor division on the meter's best scale (maximum resolution and legibility) and adjust the output of the signal generator very carefully to place the needle of the meter directly on this marker. Use the mirror to avoid parallax.

4. Set the monitor switch to position 2 and adjust the voltage divider for exactly the same reading established in step 2.

5. Carefully observing the meter, move the monitor switch alternately between positions 1 and 2 to ensure that the reading is exactly the same in both positions.

6. Compute the gain of the amplifier by taking the reciprocal of the ratio set up on the voltage divider.

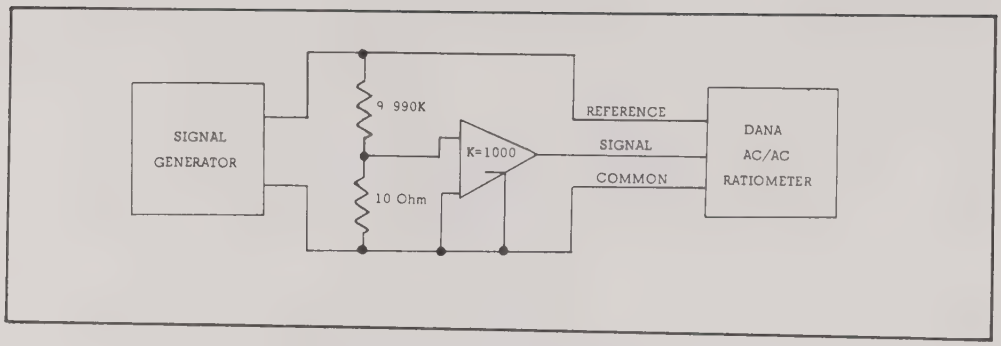



Figure 5.9 - Test Setup, High Frequency Linearity

### 5.4.4 Bandwidth Measurement

Bandwidth is measured by determining the difference in AC gain at low and at high frequencies. Since there is seldom a need to define bandwidth with extreme accuracy, the measurement procedures may be shortened as follows:

1. Use same test setup as for AC Gain Measurement, Figure 5.8.
2. Follow steps (1) through (4) for AC Gain Measurement with the signal generator set to 60 Hz.
3. Increase the frequency to 20kHz (gains 20-1000; 10kHz for gains below 20 or above 1000). Record the difference in readings between switch positions 1 and 2. If the meter has 100 minor divisions, each division represents approximately 1.4% of full scale.

In making the above measurement, it must be remembered that the bandwidth specifications apply for source impedances up to 350 ohms. When checking bandwidth make certain this value is not exceeded. If a low impedance divider is not available, it may be necessary to improvise one.

### 5.4.5 High Frequency Linearity

Linearity is determined by the following equation:

$$\text{Linearity (in \%)} = 100\ \frac{E_{out} - KE_{in}}{E_{out}\ (\text{full scale})}$$

To measure high frequency linearity, an extremely accurate AC/AC ratiometer is recommended such as the Dana Model 5400/060 or 5740. The measurement procedures are listed below:

1. Connect test setup as shown in Figure 5.9. Set the signal generator to approximately 7 volts RMS at 60 Hz. Set amplifier GAIN to 1000.

2. Trim the input divider and/or the amplifier vernier control until the absolute ratio is 0.99990 (displayed on ratiometer as 9.9990). This reading indicates a slight gain error; however, this is not important to the linearity measurement and allows the latter to be made with greater resolution.

3. Leaving all other adjustments set, increase the signal generator frequency to 2 kHz and observe the new reading on the ratiometer.

4. Compute linearity as follows:

$$\text{Linearity in \%} = \frac{\text{Reading 1 - Reading 2}}{1000}$$

If no range changes are involved, the result can be more quickly computed by allowing 0.001% for each digit of difference.

# SECTION 6

# TROUBLESHOOTING

## 6.1 GENERAL

Conventional instrumentation amplifiers are often difficult to troubleshoot, since the average malfunctions cause abnormal readings or signal levels to appear throughout the loop. By comparison, the Dana Amplifier is far easier to service since the various direct-coupled circuits can be readily isolated and inspected independently.

## 6.2 DANA REPAIR AND SERVICE POLICY

Details of Dana's repair and service policy may be found in the Dana Warranty at the rear of the manual. Items for repair should include a copy of the Dana return form describing the reason for return. Units not accompanied by this information must be held without action pending receipt of this information. A copy of this Repair/Return form is included at the rear of this manual. Additional copies may be obtained from Dana Laboratories or from Dana Sales representatives.

## 6.3 TROUBLESHOOTING GUIDES

Component failures may cause bias points to shift and loop gain to change such that the output voltage will move from near zero volts to a large positive or negative d-c voltage level. These levels are greater than $\pm 12$ volts and are called "positive lockup" and "negative lockup". Three malfunctions in the amplifier can cause output lockup. These are:

- Open or short circuit
- Defective component
- Drastic change in component characteristics

The troubleshooting guides help to isolate sections of the amplifier where the malfunction may exist. The sections can be isolated without having to break or disconnect any of the loops in the amplifier.

The step-by-step troubleshooting procedure verifies that there are no open or shorted components and that the current generators are supplying the proper currents to the circuits.

A preliminary check is to be made prior to using the troubleshooting guides. Short the P input (P1-8), N input (P1-4), and Guard (P1-7) together and connect these leads to output common (P2-1). The output voltage (P2-5) with respect to common should be near zero (zero $\pm$250 millivolt). If the output voltage is near zero, proceed to the calibration section of this manual. If the output voltage is greater than plus or minus 12 volts, the output is at lockup. Apply the troubleshooting guides in the following sequence:

1. Power Supply
2. Output Amplifier
3. 10MA Amplifier
4. Normal Mode Amplifier
5. Common Mode Amplifier
6. Feedback Network

> CAUTION
>
> The guides assume that the troubleshooter is experienced in troubleshooting solid state circuits. Non-standard practices can cause more damage to the amplifier.

Reference is made to the schematic number and assembly number where the circuit designators are located. These numbers appear at the bottom of the troubleshooting guide.

Unless the troubleshooting guide indicates otherwise, the output voltage is monitored at P2-5 (output) and P2-1 (output common).

## 6.4 TROUBLESHOOTING EQUIPMENT

All of the transistors in the amplifier can be checked in the circuit. The only exception is the output transistor Q15 of the Common Mode Amplifier, see schematic 430440). Diode CR12 is across the collector to emitter leads of transistor Q15.

The following equipments are needed to troubleshoot the amplifier:

- A Simpson VOM (volt-ohmmeter) Model 260 or equivalent, can be used to check the forward and reverse resistances of the semiconductors. Disconnect the AC power prior to making these measurements.

- A 2000 ohms, 1/4 watt, carbon resistor.
- An oscilloscope or a voltmeter capable of measuring positive and negative voltages without manually changing the polarity for monitoring the output voltage of the amplifier.
- A precision ohmmeter. The tolerance value of most precision resistors in the amplifier is 0.1%.
- Dana Cord Set - Part Number 402468.

## 6.5 COMPONENT REPLACEMENT

Defective components should be replaced with components identical to the original component. Precision wirewound resistors with 0.1% tolerances should be replaced with wirewound resistors of the same tolerance value. The characteristics of the components are critical for temperature stability, zero stability, and gain stability.

The first stage dual (Q2) and the second stage dual (Q5) of the normal mode amplifier should be ordered from the factory. The first stage dual transistor is part of a kit along with four precision resistors. This stage should be replaced as a unit. The Dana part number for the first stage kit is 400708. The kit consists of a selected dual transistor (Q2) and selected wirewound resistors R38, R39, R45, and R47.

The Dana part number for the second stage dual (Q5) of the normal mode amplifier is 201285.

Dana recommends that the components be ordered from the Dana service department. Specify the part and Dana part number for the defective component.

The amplifier should be recalibrated after replacing components. Refer to the calibration procedures in Section 5.

## 6.6 AMPLIFIER DISASSEMBLY

(1) Remove the eight number 6 Phillips Flat-Head screws from the aluminum support (right-hand side of the amplifier as viewed from the front panel).

(2) Slide the dust cover (left-hand side) to the rear of the amplifier. Remove the dust cover from the aluminum support. Refer to figure 6.1a.

(3) To remove the aluminum support, remove six number 4, Phillips pan-head screws and lock washers. These screws hold the circuit board assembly to the aluminum support. Do not remove the six number 2, Phillips pan-head screws and lock washers at this time. Three are located at the front of the circuit board and the remaining three are at

the back of the circuit board. Slide the aluminum support to the rear of the amplifier and remove. Do not allow the weight of the aluminum support to bend the circuit board assembly as breakage may occur. Refer to figure 6.1b.

(4) The guard box encloses the Input Amplifier and Feedback Network. To remove the guard box cover, remove two, number 4, Phillips pan-head screws at the top of the cover and lift the cover from the guard box. The guard box is shown in Figure 6.1c.

(5) The etched-circuit side of the Input Amplifier is electrically guarded by a fiberglass guard plate. The guard plate is held to two standoffs by two, number 4, Phillips flat-head screws. Remove the guard plate to probe the etched circuit side of the Input Amplifier.

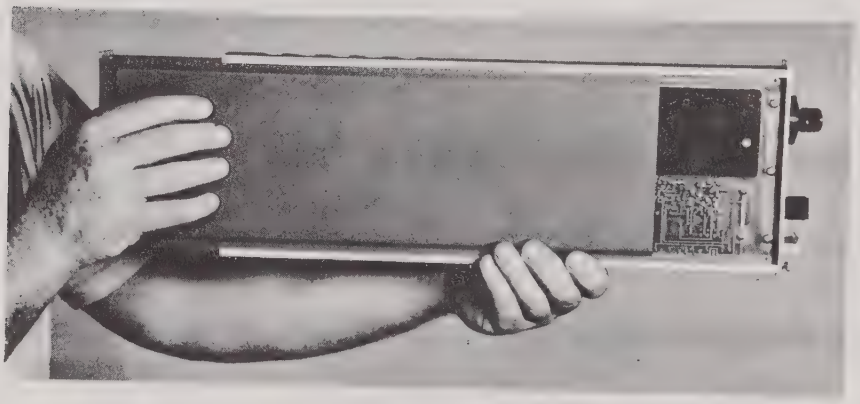


Figure 6.1a

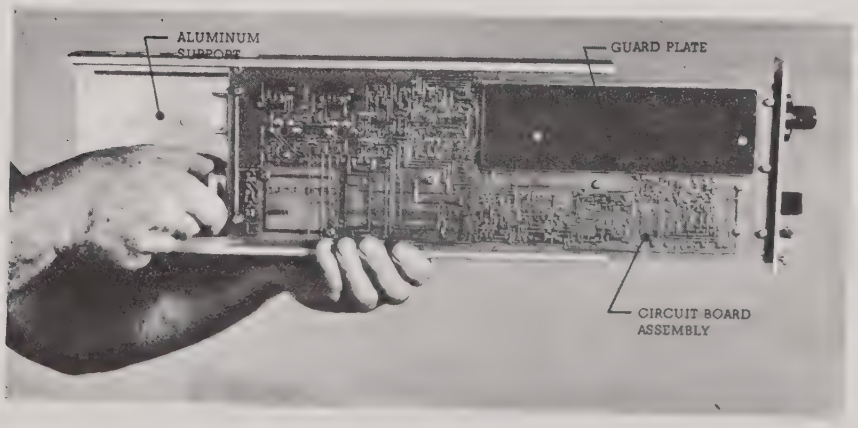



Figure 6.1b

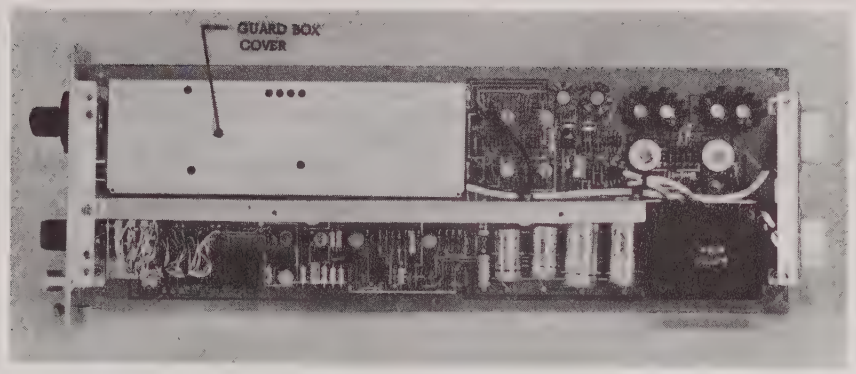



Figure 6.1c

## TROUBLESHOOTING GUIDES


Power Supply . . . . . I

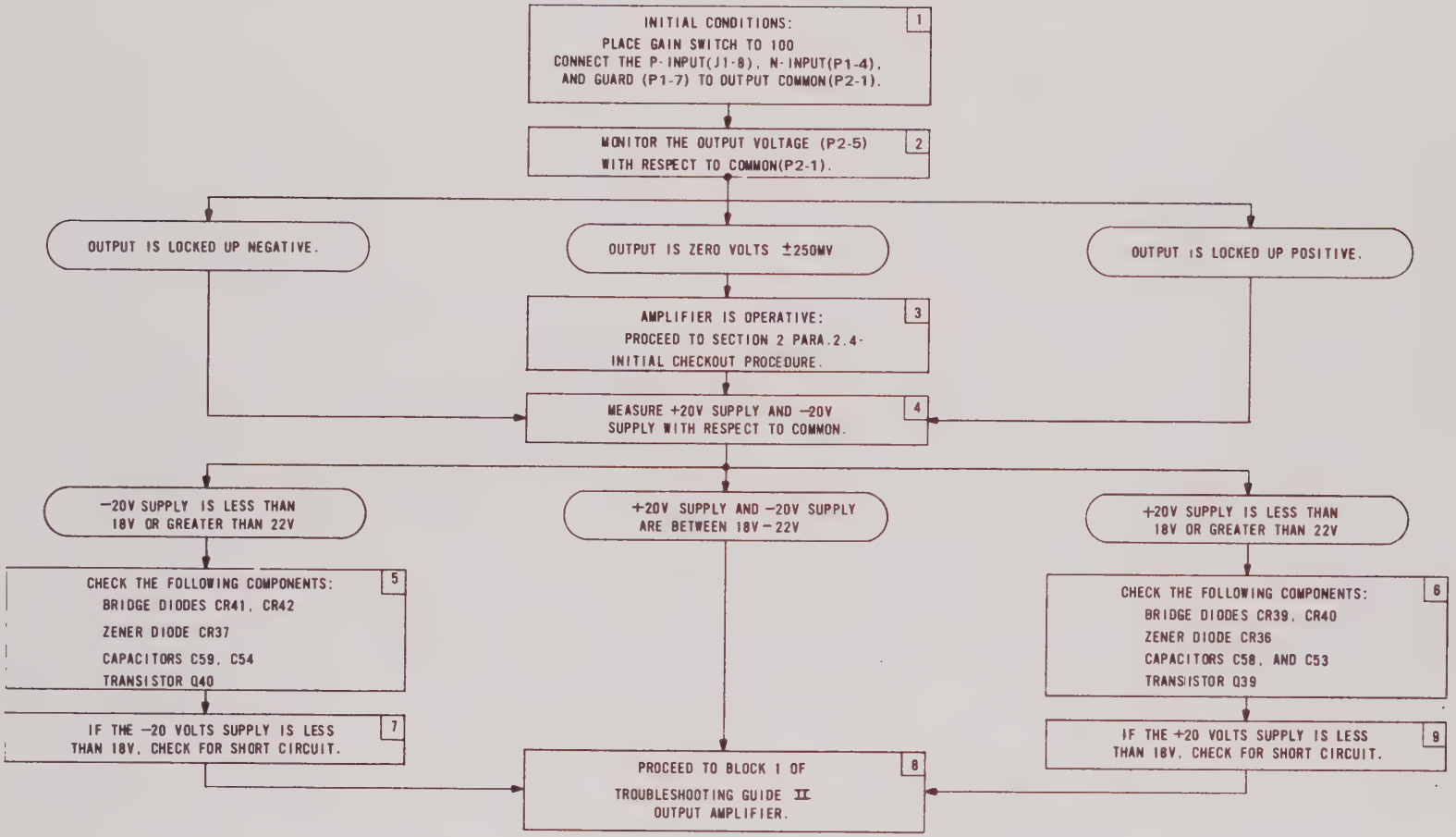
Output Amplifier . . . . . II

10 MA Amplifier . . . . . III

Normal Mode Amplifier (2 sheets) . . . . . IV

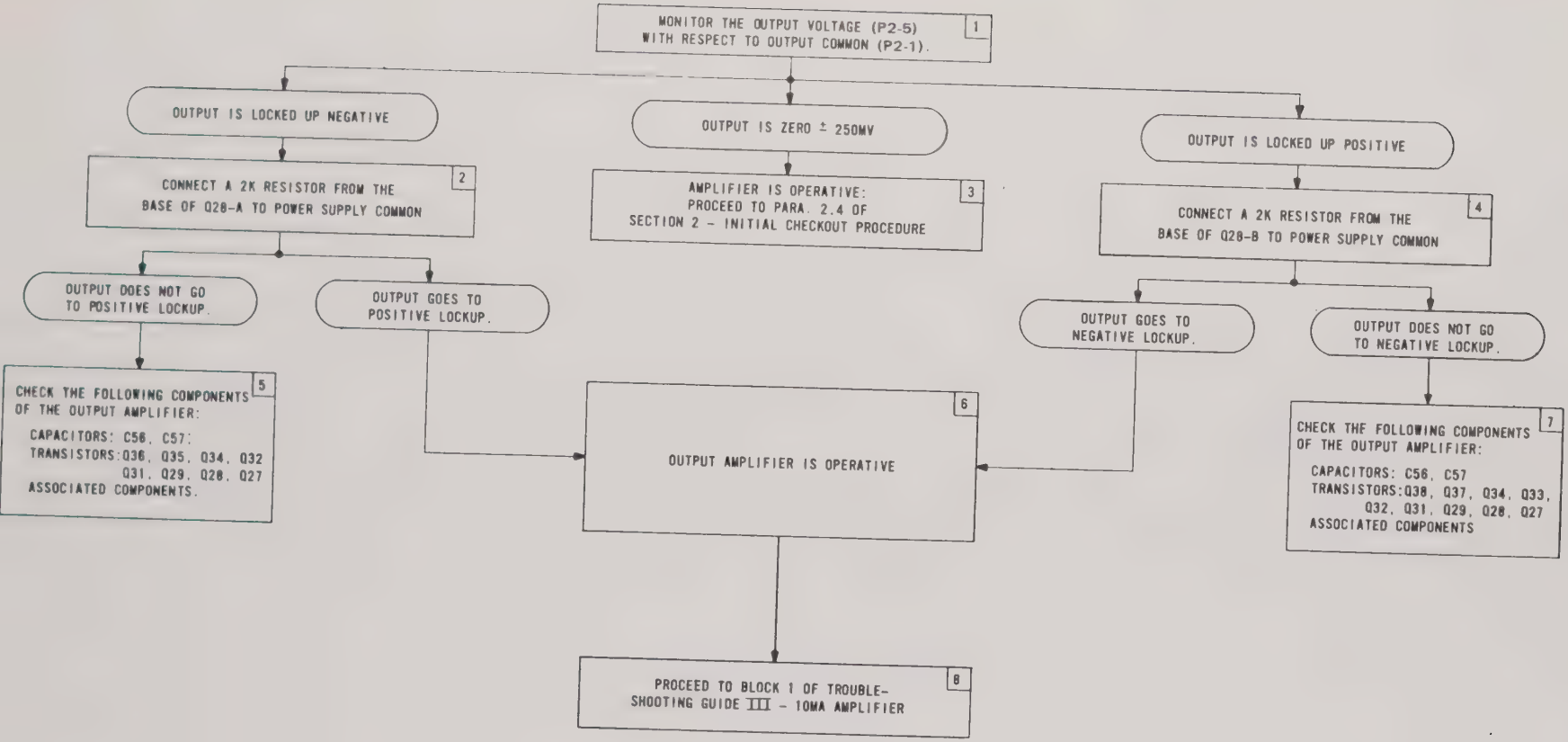
Common Mode Amplifier . . . . . V

Feedback Network . . . . . VI



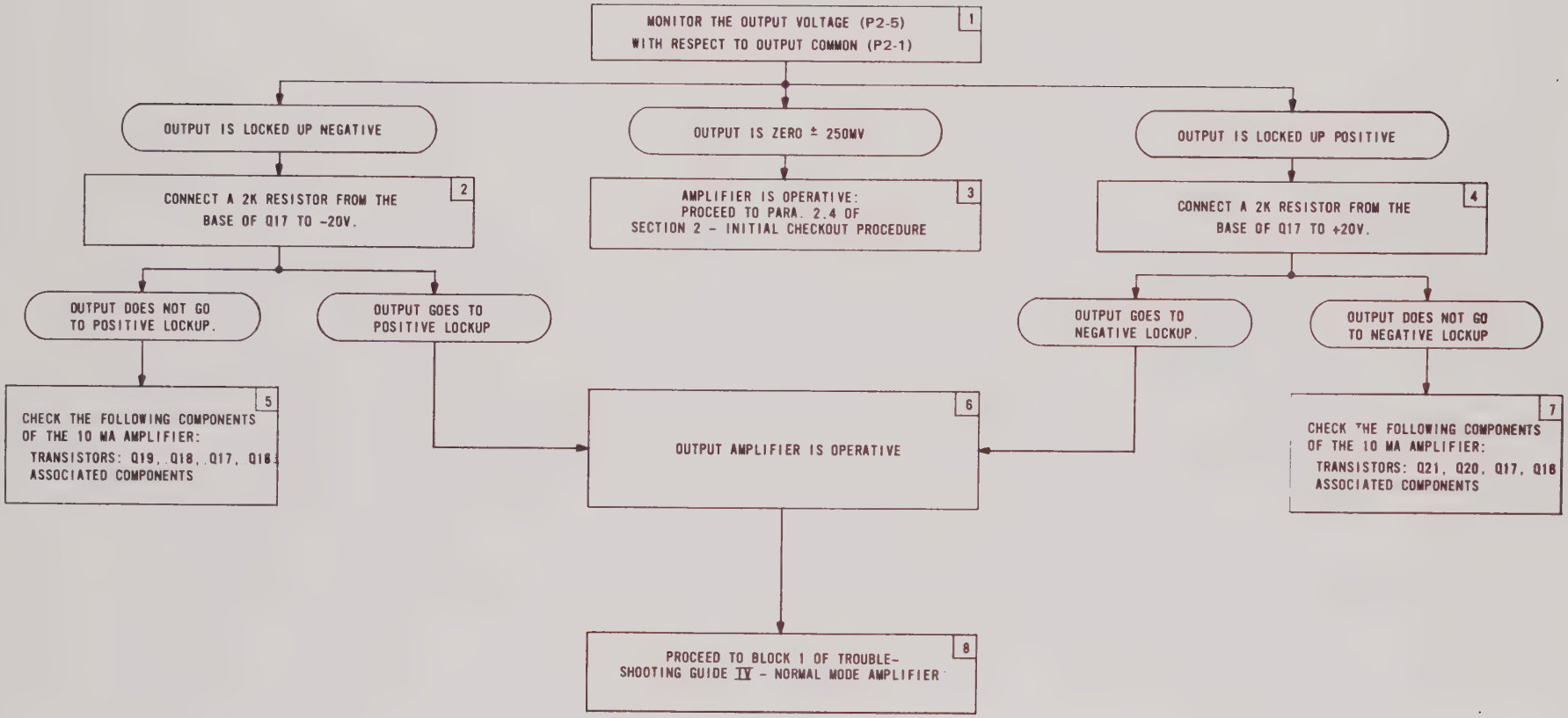

TROUBLESHOOTING GUIDE I
SHEET 1 OF 1
MODEL 2850-POWER SUPPLY

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402311, 402312 |
| V3 | 430630 | 402392, 402312 |


MONITOR THE OUTPUT VOLTAGE (P2-5) WITH RESPECT TO OUTPUT COMMON (P2-1). 1
OUTPUT IS LOCKED UP NEGATIVE
OUTPUT IS ZERO ± 250MV
OUTPUT IS LOCKED UP POSITIVE
CONNECT A 2K RESISTOR FROM THE BASE OF Q28-A TO POWER SUPPLY COMMON 2
AMPLIFIER IS OPERATIVE: PROCEED TO PARA. 2.4 OF SECTION 2 - INITIAL CHECKOUT PROCEDURE 3
CONNECT A 2K RESISTOR FROM THE BASE OF Q28-B TO POWER SUPPLY COMMON 4
OUTPUT DOES NOT GO TO POSITIVE LOCKUP.
OUTPUT GOES TO POSITIVE LOCKUP.
OUTPUT GOES TO NEGATIVE LOCKUP.
OUTPUT DOES NOT GO TO NEGATIVE LOCKUP.
CHECK THE FOLLOWING COMPONENTS OF THE OUTPUT AMPLIFIER: 5
CAPACITORS: C56, C57;
TRANSISTORS: Q36, Q35, Q34, Q32 Q31, Q29, Q28, Q27
ASSOCIATED COMPONENTS.
6
OUTPUT AMPLIFIER IS OPERATIVE
CHECK THE FOLLOWING COMPONENTS OF THE OUTPUT AMPLIFIER: 7
CAPACITORS: C56, C57
TRANSISTORS: Q38, Q37, Q34, Q33, Q32, Q31, Q29, Q28, Q27
ASSOCIATED COMPONENTS
PROCEED TO BLOCK 1 OF TROUBLE-SHOOTING GUIDE III - 10MA AMPLIFIER 8

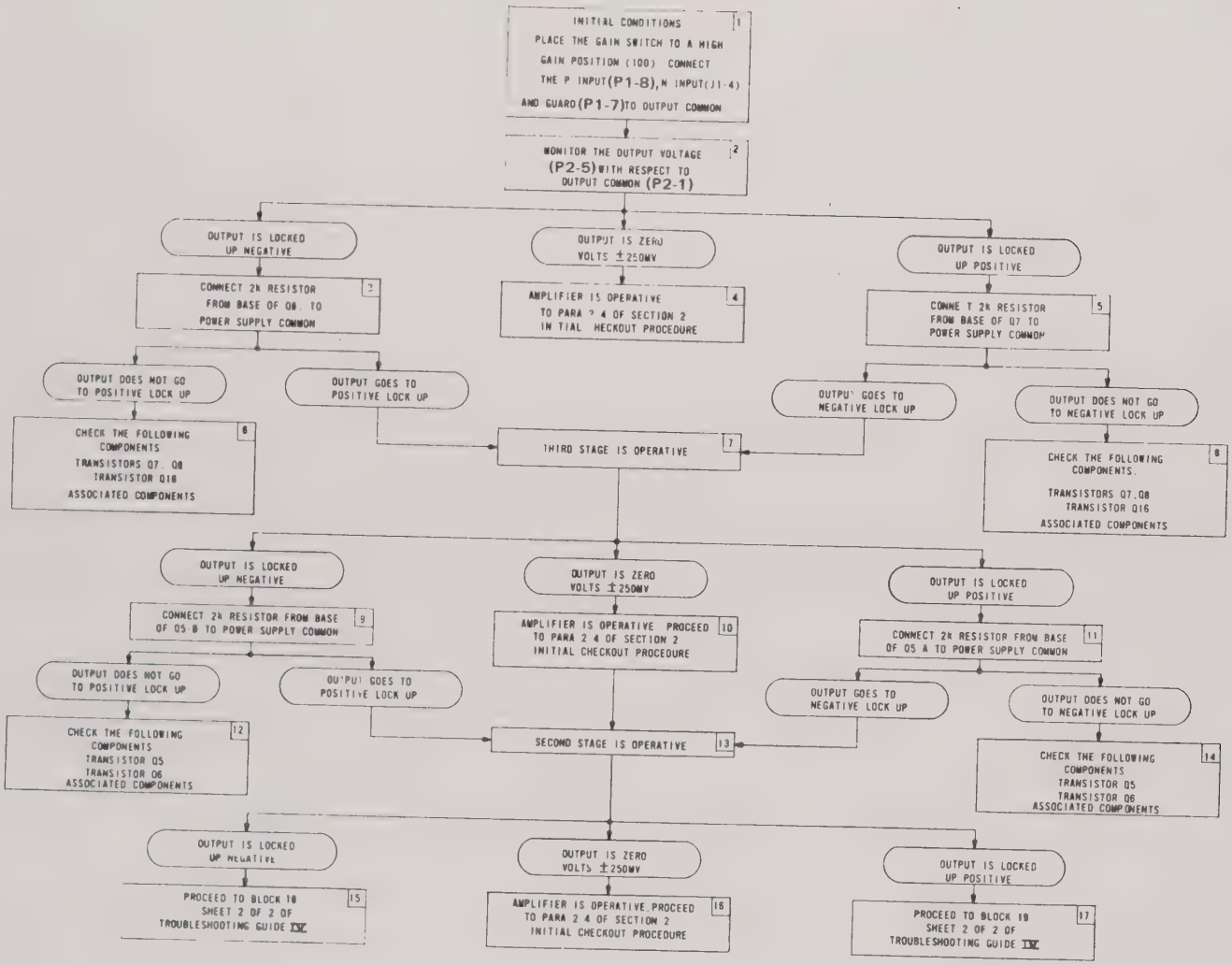
TROUBLESHOOTING GUIDE II
SHEET 1 OF 1
MODEL 2850 - 100MA OUTPUT AMPLIFIER

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402311, 402312 |
| V3 | 430630 | 402392, 402312 |



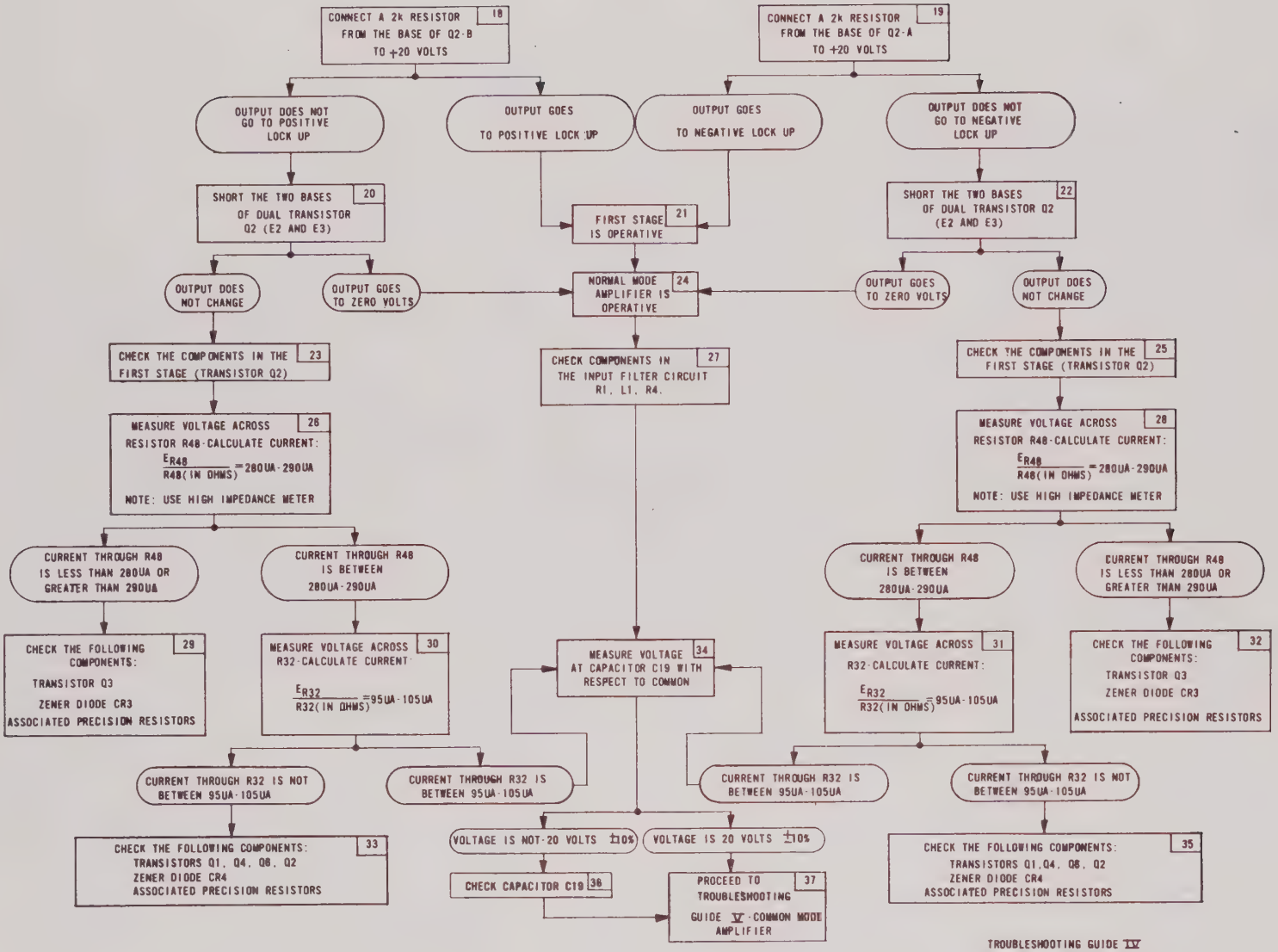

TROUBLESHOOTING GUIDE III
SHEET 1 OF 1
MODEL 2850 - 10MA AMPLIFIER

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402311, 402312 |
| V3 | 430630 | 402392, 402312 |


INITIAL CONDITIONS
1
PLACE THE GAIN SWITCH TO A HIGH GAIN POSITION (100) CONNECT THE P INPUT (P1-8), N INPUT (J1-4) AND GUARD (P1-7) TO OUTPUT COMMON
MONITOR THE OUTPUT VOLTAGE (P2-5) WITH RESPECT TO OUTPUT COMMON (P2-1)
2
OUTPUT IS LOCKED UP NEGATIVE
OUTPUT IS ZERO VOLTS ±250MV
OUTPUT IS LOCKED UP POSITIVE
CONNECT 2K RESISTOR FROM BASE OF Q8 TO POWER SUPPLY COMMON
3
AMPLIFIER IS OPERATIVE TO PARA 2.4 OF SECTION 2 INITIAL CHECKOUT PROCEDURE
4
CONNECT 2K RESISTOR FROM BASE OF Q7 TO POWER SUPPLY COMMON
5
OUTPUT DOES NOT GO TO POSITIVE LOCK UP
OUTPUT GOES TO POSITIVE LOCK UP
OUTPUT GOES TO NEGATIVE LOCK UP
OUTPUT DOES NOT GO TO NEGATIVE LOCK UP
CHECK THE FOLLOWING COMPONENTS
TRANSISTORS Q7, Q8
TRANSISTOR Q18
ASSOCIATED COMPONENTS
8
THIRD STAGE IS OPERATIVE
7
CHECK THE FOLLOWING COMPONENTS
TRANSISTORS Q7, Q8
TRANSISTOR Q16
ASSOCIATED COMPONENTS
8
OUTPUT IS LOCKED UP NEGATIVE
OUTPUT IS ZERO VOLTS ±250MV
OUTPUT IS LOCKED UP POSITIVE
CONNECT 2K RESISTOR FROM BASE OF Q5-B TO POWER SUPPLY COMMON
9
AMPLIFIER IS OPERATIVE PROCEED TO PARA 2.4 OF SECTION 2 INITIAL CHECKOUT PROCEDURE
10
CONNECT 2K RESISTOR FROM BASE OF Q5 A TO POWER SUPPLY COMMON
11
OUTPUT DOES NOT GO TO POSITIVE LOCK UP
OUTPUT GOES TO POSITIVE LOCK UP
OUTPUT GOES TO NEGATIVE LOCK UP
OUTPUT DOES NOT GO TO NEGATIVE LOCK UP
CHECK THE FOLLOWING COMPONENTS
TRANSISTOR Q5
TRANSISTOR Q6
ASSOCIATED COMPONENTS
12
SECOND STAGE IS OPERATIVE
13
CHECK THE FOLLOWING COMPONENTS
TRANSISTOR Q5
TRANSISTOR Q6
ASSOCIATED COMPONENTS
14
OUTPUT IS LOCKED UP NEGATIVE
OUTPUT IS ZERO VOLTS ±250MV
OUTPUT IS LOCKED UP POSITIVE
PROCEED TO BLOCK 18 SHEET 2 OF 2 OF TROUBLESHOOTING GUIDE IV
15
AMPLIFIER IS OPERATIVE PROCEED TO PARA 2.4 OF SECTION 2 INITIAL CHECKOUT PROCEDURE
16
PROCEED TO BLOCK 19 SHEET 2 OF 2 OF TROUBLESHOOTING GUIDE IV
17

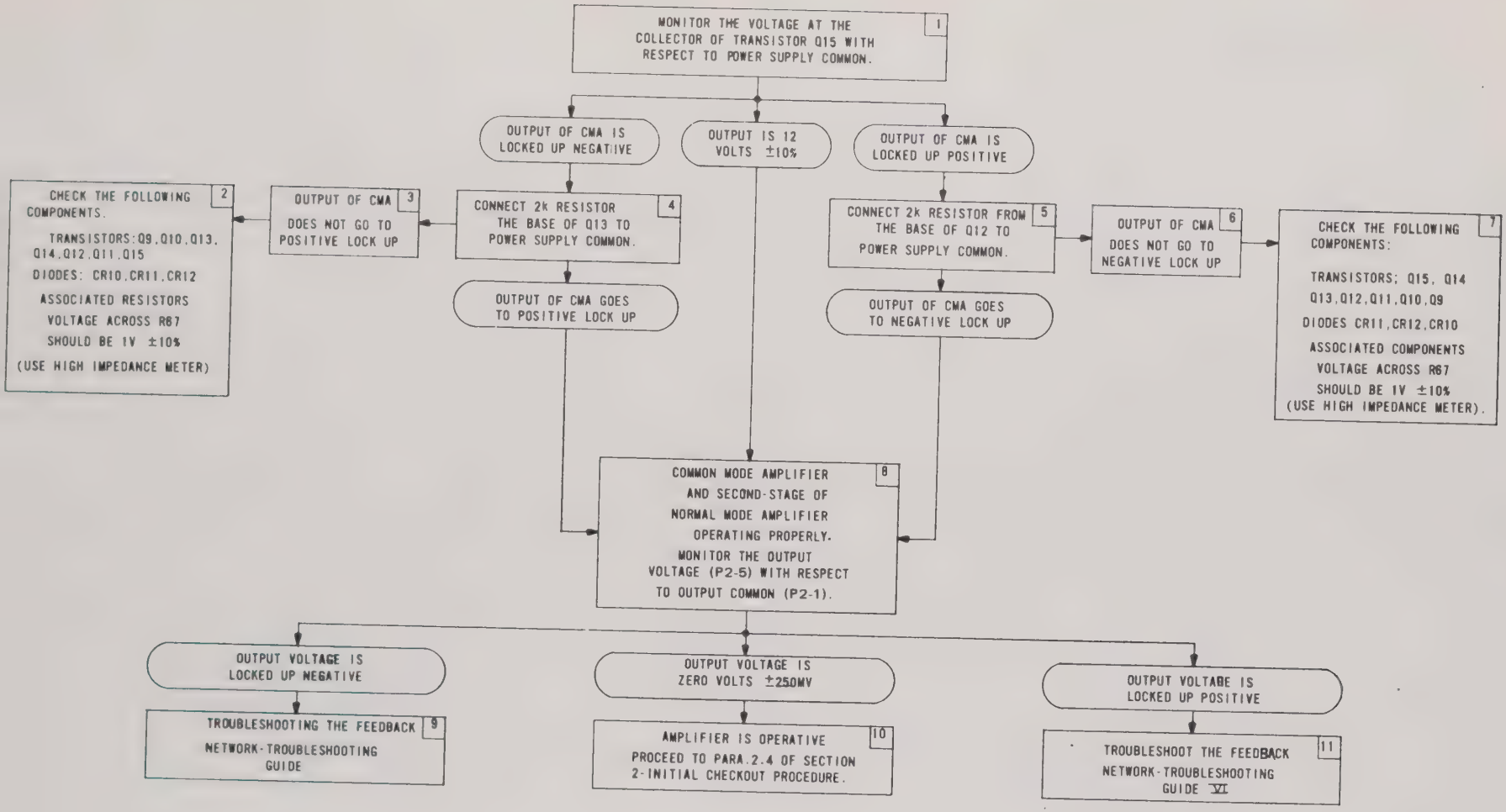
TROUBLESHOOTING GUIDE IV
SHEET 1 OF 2
MODEL 2850-NORMAL MODE AMPLIFIER

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402311, 402312 |
| V3 | 430830 | 402392, 402312 |


18 CONNECT A 2k RESISTOR FROM THE BASE OF Q2-B TO +20 VOLTS
19 CONNECT A 2k RESISTOR FROM THE BASE OF Q2-A TO +20 VOLTS
OUTPUT DOES NOT GO TO POSITIVE LOCK UP
OUTPUT GOES TO POSITIVE LOCK UP
OUTPUT GOES TO NEGATIVE LOCK UP
OUTPUT DOES NOT GO TO NEGATIVE LOCK UP
20 SHORT THE TWO BASES OF DUAL TRANSISTOR Q2 (E2 AND E3)
21 FIRST STAGE IS OPERATIVE
22 SHORT THE TWO BASES OF DUAL TRANSISTOR Q2 (E2 AND E3)
OUTPUT DOES NOT CHANGE
OUTPUT GOES TO ZERO VOLTS
24 NORMAL MODE AMPLIFIER IS OPERATIVE
OUTPUT GOES TO ZERO VOLTS
OUTPUT DOES NOT CHANGE
23 CHECK THE COMPONENTS IN THE FIRST STAGE (TRANSISTOR Q2)
27 CHECK COMPONENTS IN THE INPUT FILTER CIRCUIT R1, L1, R4.
25 CHECK THE COMPONENTS IN THE FIRST STAGE (TRANSISTOR Q2)
26 MEASURE VOLTAGE ACROSS RESISTOR R48-CALCULATE CURRENT: E R48 / R48(IN OHMS) = 280UA-290UA NOTE: USE HIGH IMPEDANCE METER
28 MEASURE VOLTAGE ACROSS RESISTOR R48-CALCULATE CURRENT: E R48 / R48(IN OHMS) = 280UA-290UA NOTE: USE HIGH IMPEDANCE METER
CURRENT THROUGH R48 IS LESS THAN 280UA OR GREATER THAN 290UA
CURRENT THROUGH R48 IS BETWEEN 280UA-290UA
CURRENT THROUGH R48 IS BETWEEN 280UA-290UA
CURRENT THROUGH R48 IS LESS THAN 280UA OR GREATER THAN 290UA
29 CHECK THE FOLLOWING COMPONENTS: TRANSISTOR Q3 ZENER DIODE CR3 ASSOCIATED PRECISION RESISTORS
30 MEASURE VOLTAGE ACROSS R32-CALCULATE CURRENT E R32 / R32(IN OHMS) = 95UA-105UA
34 MEASURE VOLTAGE AT CAPACITOR C19 WITH RESPECT TO COMMON
31 MEASURE VOLTAGE ACROSS R32-CALCULATE CURRENT: E R32 / R32(IN OHMS) = 95UA-105UA
32 CHECK THE FOLLOWING COMPONENTS: TRANSISTOR Q3 ZENER DIODE CR3 ASSOCIATED PRECISION RESISTORS
CURRENT THROUGH R32 IS NOT BETWEEN 95UA-105UA
CURRENT THROUGH R32 IS BETWEEN 95UA-105UA
CURRENT THROUGH R32 IS BETWEEN 95UA-105UA
CURRENT THROUGH R32 IS NOT BETWEEN 95UA-105UA
33 CHECK THE FOLLOWING COMPONENTS: TRANSISTORS Q1, Q4, Q8, Q2 ZENER DIODE CR4 ASSOCIATED PRECISION RESISTORS
VOLTAGE IS NOT-20 VOLTS ±10%
VOLTAGE IS 20 VOLTS ±10%
35 CHECK THE FOLLOWING COMPONENTS: TRANSISTORS Q1,Q4, Q8, Q2 ZENER DIODE CR4 ASSOCIATED PRECISION RESISTORS
36 CHECK CAPACITOR C19
37 PROCEED TO TROUBLESHOOTING GUIDE V - COMMON MODE AMPLIFIER

TROUBLESHOOTING GUIDE IV
SHEET 2 OF 2
MODEL 2850-NORMAL MODE AMPLIFIER

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402311, 402312 |
| V3 | 430430 | 402392, 402312 |

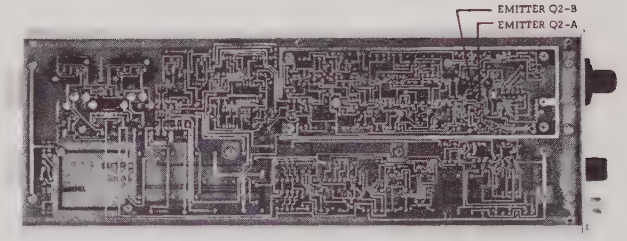

1
MONITOR THE VOLTAGE AT THE COLLECTOR OF TRANSISTOR Q15 WITH RESPECT TO POWER SUPPLY COMMON.
OUTPUT OF CMA IS LOCKED UP NEGATIVE
OUTPUT IS 12 VOLTS ±10%
OUTPUT OF CMA IS LOCKED UP POSITIVE
2
CHECK THE FOLLOWING COMPONENTS.
TRANSISTORS:Q9,Q10,Q13, Q14,Q12,Q11,Q15
DIODES: CR10,CR11,CR12
ASSOCIATED RESISTORS
VOLTAGE ACROSS R67 SHOULD BE 1V ±10%
(USE HIGH IMPEDANCE METER)
3
OUTPUT OF CMA DOES NOT GO TO POSITIVE LOCK UP
4
CONNECT 2k RESISTOR THE BASE OF Q13 TO POWER SUPPLY COMMON.
OUTPUT OF CMA GOES TO POSITIVE LOCK UP
5
CONNECT 2k RESISTOR FROM THE BASE OF Q12 TO POWER SUPPLY COMMON.
OUTPUT OF CMA GOES TO NEGATIVE LOCK UP
6
OUTPUT OF CMA DOES NOT GO TO NEGATIVE LOCK UP
7
CHECK THE FOLLOWING COMPONENTS:
TRANSISTORS; Q15, Q14 Q13,Q12,Q11,Q10,Q9
DIODES CR11,CR12,CR10
ASSOCIATED COMPONENTS
VOLTAGE ACROSS R67 SHOULD BE 1V ±10%
(USE HIGH IMPEDANCE METER).
8
COMMON MODE AMPLIFIER AND SECOND-STAGE OF NORMAL MODE AMPLIFIER OPERATING PROPERLY.
MONITOR THE OUTPUT VOLTAGE (P2-5) WITH RESPECT TO OUTPUT COMMON (P2-1).
OUTPUT VOLTAGE IS LOCKED UP NEGATIVE
OUTPUT VOLTAGE IS ZERO VOLTS ±250MV
OUTPUT VOLTAGE IS LOCKED UP POSITIVE
9
TROUBLESHOOTING THE FEEDBACK NETWORK-TROUBLESHOOTING GUIDE
10
AMPLIFIER IS OPERATIVE
PROCEED TO PARA.2.4 OF SECTION 2-INITIAL CHECKOUT PROCEDURE.
11
TROUBLESHOOT THE FEEDBACK NETWORK-TROUBLESHOOTING GUIDE V

TROUBLESHOOTING GUIDE V
SHEET 1 OF 1
MODEL 2850-COMMON MODE AMPLIFIER (CMA)

| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402331, 402312 |
| V3 | 430630 | 402392, 402312 |

1. REMOVE THE AC POWER FROM THE AMPLIFIER. FOR V2 OPTION-PLACE THE MULTIPLIER SWITCH TO THE X1 POSITION.

2. MEASURE THE RESISTANCE BETWEEN THE EMITTERS OF TRANSISTOR Q2




3. THE RESISTANCE VALUE FOR EACH GAIN POSITION SHOULD BE:

| GAIN | RESISTANCE |
|---|---|
| 20 | 13.50k ±1% |
| 50 | 5.38k ±1% |
| 100 | 2.73k ±1% |
| 200 | 1.37k ±1% |
| 500 | .539k ±1% |
| 1000 | .275k ±1% |

SOME RESISTANCE VALUES BUT NOT ALL RESISTANCE VALUES ARE OUT OF TOLERANCE

4. CHECK THE GAIN RESISTOR

| GAIN | RESISTOR |
|---|---|
| 50 | R15 |
| 100 | R16 |
| 200 | R17 |
| 500 | R18 |
| 1000 | R19 |

ALL RESISTANCE MEASUREMENTS ARE OUT OF TOLERANCE.

5. CHECK THE RESISTORS IN THE FEEDBACK NETWORK:

R20, R24, R21, R23, R26

AND POTENTIOMER R25.

CHECK RESISTORS R40, R41, R42 R43, R44, AND R46.

CHECK R45 AND R47; THE VALUES OF THESE TWO RESISTORS ARE STAMPED ON THE RESISTOR

RESISTANCE VALUES ARE WITHIN TOLERANCE

6. APPLY THE AC POWER TO THE AMPLIFIER.

PLACE THE GAIN SWITCH TO A HIGH GAIN POSITION(100)

CONNECT THE P-INPUT(P1-8) N-INPUT(P1-4)AND GUARD(P1-7) TO OUTPUT COMMON(P2-1)

7. MONITOR THE OUTPUT(P2-5) WITH RESPECT TO OUTPUT COMMON(P2-1).

OUTPUT IS LOCKED UP POSITIVE OR NEGATIVE

8. MAKE CERTAIN NONE OF THE TROUBLESHOOTING STEPS WERE OVERLOOKED.

RETURN AMPLIFIER TO DANA LABORATORIES ALONG WITH REPAIR/RETURN FORM.

OUTPUT IS ZERO ±250MV

9. PROCEED TO PARA.2.4 OF SECTION 2 INITIAL CHECKOUT PROCEDURE

TROUBLESHOOTING GUIDE VI
SHEET 1 OF 1
MODEL 2850-FEEDBACK NETWORK

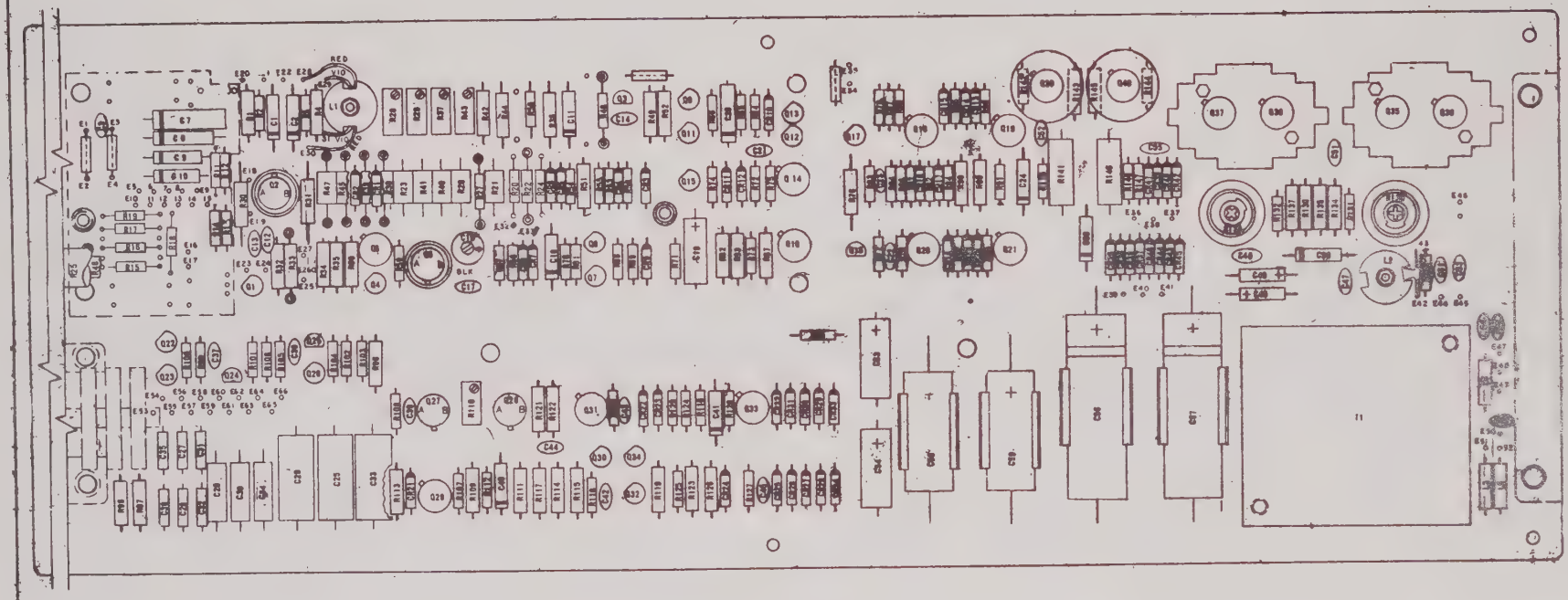
| OPTION | SCHEMATIC | ASSEMBLY |
|---|---|---|
| V1 | 430440 | 402310, 402312 |
| V2 | 430441 | 402331, 402312 |
| V3 | 430630 | 402392, 402312 |

# SECTION 7

# DRAWINGS AND PARTS LISTS

## 7.1 DRAWINGS

| | |
|---|---|
| PC Board Assembly 2850-V1 | 402310 |
| PC Board Assembly 2850-V2 | 402311 |
| PC Board Assembly 2850-V3 | 402392 |
| Schematic Amplifier 2850-V1 | 430440 |
| Schematic Amplifier 2850-V2 | 430441 |
| Schematic Amplifier 2850-V3 | 430630 |
| Outline Dimension Amplifier Model 2850 | 452401 |
| Outline Dimension Enclosure Model 2808-1 | 452402 |
| Outline Dimension Enclosure Model 2808-2 | 452403 |
| Wiring Diagram 2808-1 | 430590 |
| Wiring Diagram 2808-2 | 430591 |
| Enclosure Assembly 2802-2 | 402948 |



| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR NO. | DWG NO. |
|---|---|---|---|---|---|
| | | LIST OF MATERIAL OR PARTS LIST | | | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS ± .XX ± .XXX; ANGLES 0° 30'; FORMED ANGLES 1°

MATERIAL

FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

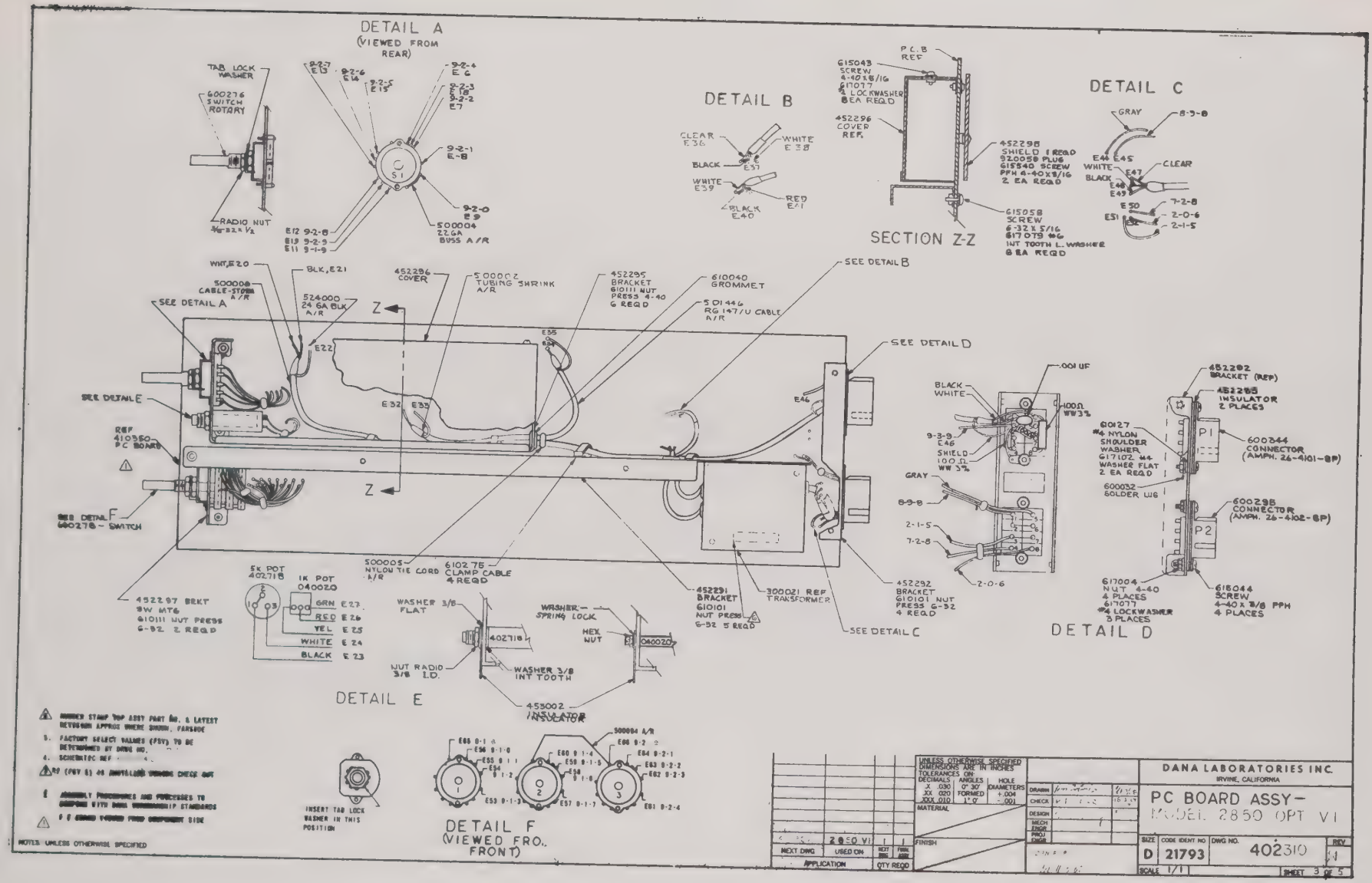
| | | |
|---|---|---|
| DRAWN | Jim Gilreau | 4/14/72 |
| CHECK | L. Malone | 4/17/72 |
| TOOL ENGR | | |
| PROJ ENGR | Rejsek | 4/24/72 |

P.C. BOARD ASSY—
MODEL 2850 ORT VI

| SIZE | CODE IDENT NO. | DWG NO. |
|---|---|---|
| D | 21793 | 402310 |

SHEET 1/1

| NEXT ASSY | USED ON | MA | FA |
|---|---|---|---|
| 402107 | 2850 V-1 | 1 | |
| APPLICATION | | QTY REQD | |




⚠ MARKER STAMP TOP ASSY PART NO. & LATEST REVISION APPROX WHERE SHOWN, PARADOX

5. FACTORY SELECT VALUES (FSV) TO BE DETERMINED BY DANA NO.
4. SCHEMATIC REF
⚠ (PBT 61) AS INSTALLED DURING CHECK OUT
ASSEMBLY PROCEDURES AND PROCESSES TO COMPLY WITH DANA WORKMANSHIP STANDARDS
⚠ ADDED POTTED FOOD COMPONENT SIDE

NOTES: UNLESS OTHERWISE SPECIFIED

| NEXT DWG | USED ON | NEXT ASSY | PARENT ASSY |
|---|---|---|---|
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010 | ANGLES 0° 30' FORMED 1°0' | HOLE DIAMETERS +.004 -.001
MATERIAL
FINISH

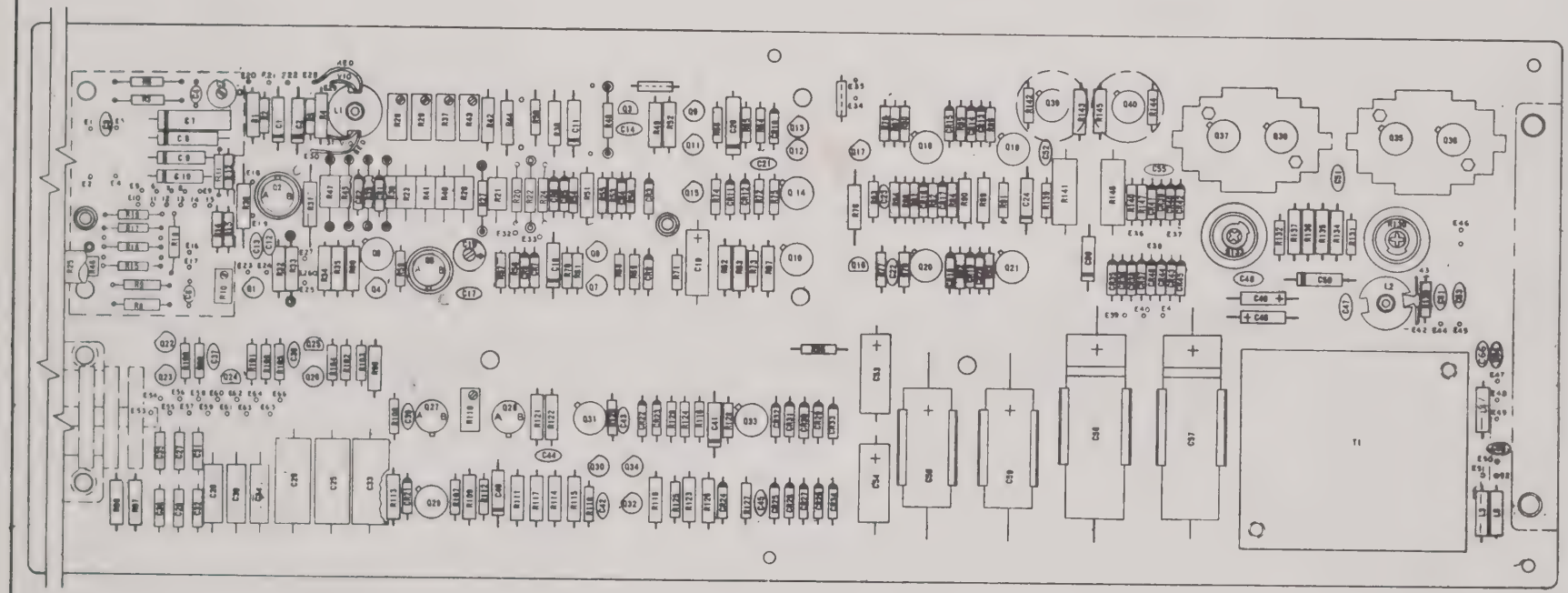
| | | |
|---|---|---|
| DRAWN | | |
| CHECK | | |
| DESIGN | | |
| MECH ENGR | | |
| PROJ ENGR | | |

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

# PC BOARD ASSY — MODEL 2850 OPT V1

| SIZE | CODE IDENT NO | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 402310 | N |

SCALE 1/1 SHEET 3 OF 5



| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|
| 1 | 402308 | 2850 V2 | | | |

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .030, XX .010, XXX .005; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

| | | |
|---|---|---|
| DRAWN | JIM GARCAU | 4/14/67 |
| CHECK | L. MALOUF | 5/19/67 |
| COST ENGR | | |
| PROJ ENGR | KEWERT | 6/1/67 |

Dru # 684
Ca 11-2-67

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

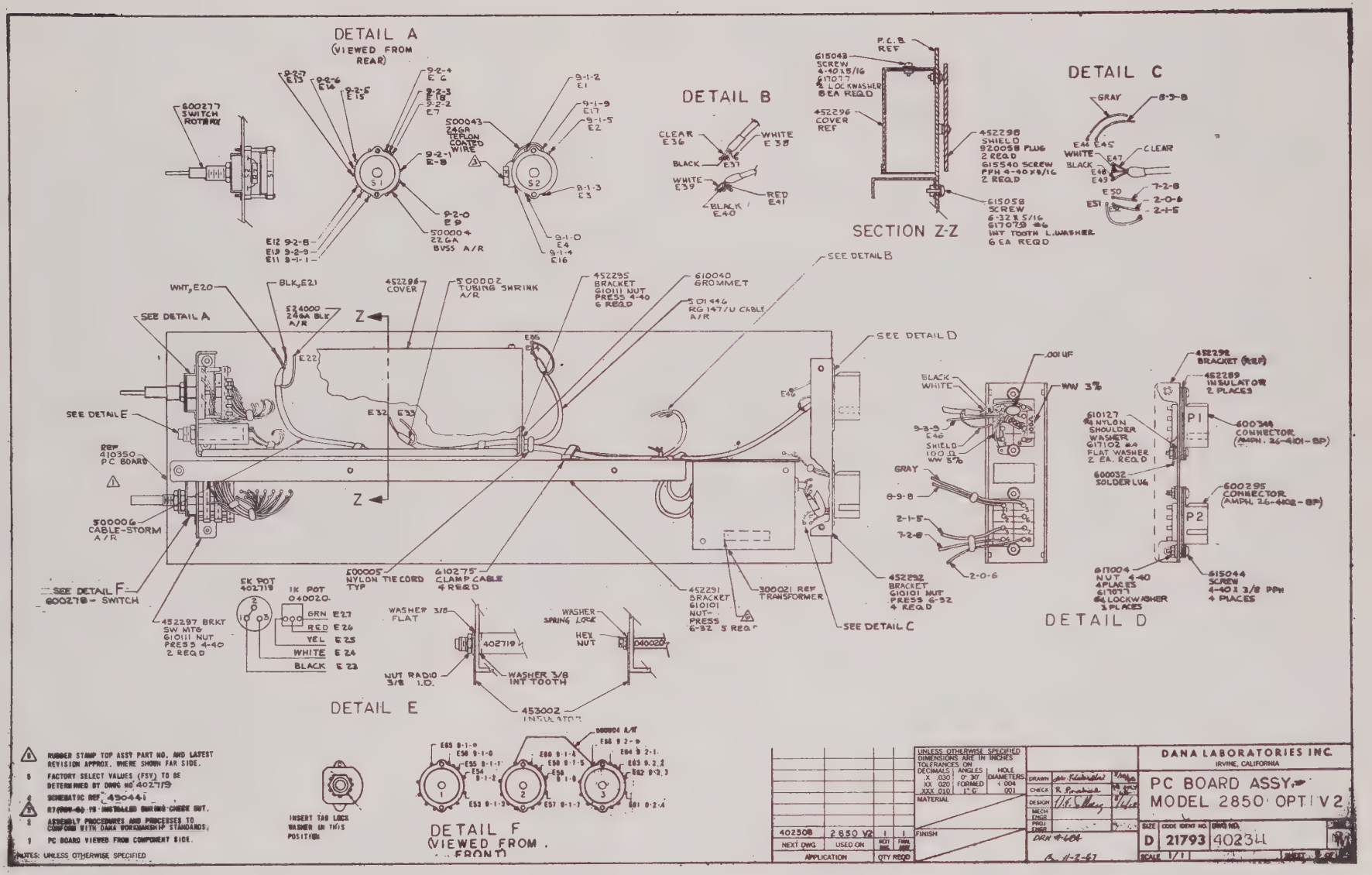
P.C. BOARD ASSY—
MODEL 2850 OPT V2

| SIZE | CAGE SHEET NO. | DWG NO. |
|---|---|---|
| D | 21793 | 402311 |

SCALE 1/1 SHT

| NEXT ASSY | USED ON | NA | FA |
|---|---|---|---|
| APPLICATION | | QTY REQD | |

NOTE: UNLESS OTHERWISE SPECIFIED


DETAIL A
(VIEWED FROM REAR)
600277 SWITCH ROTARY
S1
S2
S00004 22GA BUSS A/R
DETAIL B
CLEAR E36
WHITE E38
BLACK E37
WHITE E39
RED E41
BLACK E40
P.C.B REF
615043 SCREW 4-40 X 5/16 617077 LOCKWASHER 8 EA REQ'D
452296 COVER REF
452298 SHIELD 920058 PLUG 2 REQ'D 615540 SCREW PPH 4-40 X 5/16 2 REQ'D
615058 SCREW 6-32 X 5/16 617079 #6 INT TOOTH L.WASHER 6 EA REQ'D
SECTION Z-Z
DETAIL C
GRAY
WHITE
BLACK
CLEAR
E44 E45
E47
E48
E49
E50
E51
SEE DETAIL A
SEE DETAIL B
SEE DETAIL C
SEE DETAIL D
SEE DETAIL E
SEE DETAIL F
WHT, E20
BLK, E21
E24000 24GA BLK A/R
452296 COVER
S00002 TUBING SHRINK A/R
452295 BRACKET 610111 NUT PRESS 4-40 6 REQ'D
610040 GROMMET
5D1446 RG 147/U CABLE A/R
REF 410350 P.C. BOARD
300006 CABLE-STORM A/R
452297 BRKT SW MTG 610111 NUT PRESS 4-40 2 REQ'D
S00005 NYLON TIE CORD TYP
610275 CLAMP CABLE 4 REQ'D
452291 BRACKET 610101 NUT-PRESS 6-32 5 REQ'D
300021 REF TRANSFORMER
452292 BRACKET 610101 NUT PRESS 6-32 4 REQ'D
.001 UF
WW 3%
BLACK
WHITE
9-3-9 E46
SHIELD 100 Ω WW 3%
GRAY
8-9-8
2-1-5
7-2-8
2-0-6
452292 BRACKET (REF)
452289 INSULATOR 2 PLACES
610127 NYLON SHOULDER WASHER 617102 FLAT WASHER 2 EA. REQ'D
600032 SOLDER LUG
600340 CONNECTOR (AMPH. 26-4101-BP)
600295 CONNECTOR (AMPH. 26-4102-BP)
617004 NUT 4-40 4 PLACES 617077 LOCKWASHER 3 PLACES
615044 SCREW 4-40 X 3/8 PPH 4 PLACES
P1
P2
1K POT 402719
1K POT 040020
GRN E27
RED E26
YEL E25
WHITE E24
BLACK E23
DETAIL E
WASHER FLAT 3/8
WASHER SPRING LOCK
HEX NUT
NUT RADIO 3/8 I.D.
WASHER 3/8 INT TOOTH
453002 INSULATOR
DETAIL F
(VIEWED FROM FRONT)
INSERT TAB LOCK WASHER IN THIS POSITION
RUBBER STAMP TOP ASSY PART NO. AND LATEST REVISION APPROX. WHERE SHOWN FAR SIDE.
FACTORY SELECT VALUES (FSV) TO BE DETERMINED BY DWG NO 402719
SCHEMATIC REF. 430441
ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.
PC BOARD VIEWED FROM COMPONENT SIDE.
NOTES: UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS X .030 XX .020 XXX .010 ANGLES 0° 30' FORMED 1° 0" HOLE DIAMETERS ± .004 .001
MATERIAL
FINISH
DRAWN
CHECK R. Prentice
DESIGN
MECH ENGR
PROJ ENGR
DRN # 604
8-11-3-67
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
PC BOARD ASSY
MODEL 2850 OPT V2
SIZE D
CODE IDENT NO. 21793
DWG NO. 402311
SCALE 1/1
SHEET 1 OF 1
402308 2850 V2 1 1
NEXT DWG USED ON NOT USED FINAL ASSY
APPLICATION QTY REQ'D

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| C1 | 121082 | [illegible] | 3 |
| C2 | 121083 | 0022UF/100V | REF |
| C3 | 101174 | [illegible] | 8 |
| C4 | 100006 | 10pF DISC | 2 |
| C5 | 130004 | 2-8pF/DISC | 2 |
| C6 | 101641 | 470pF DISC | 3 |
| C7 | 121093 | 047UF/100V | 1 |
| C8 | 121091 | [illegible] | 2 |
| C9 | 121088 | 01UF/100V | 3 |
| C10 | 121088 | 01UF/100V | X |
| C11 | 121088 | 01UF/100V | REF |
| C12 | 101145 | 100 pF DISC | 4 |
| C13 | 101145 | 100 pF DISC | REF |
| C14 | 101641 | 470 pF DISC | REF |
| C15 | 130004 | 2-8 pF VARIABLE | REF |
| C16 | | NOT USED | REF |
| C17 | 100009 | 5 pF DISC | |
| C18 | 121088 | [illegible] | REF |
| C19 | 111292 | 10UF/25V | 1 |
| C20 | 121091 | [illegible] | REF |
| C21 | 101641 | 470 pF DISC | REF |
| C22 | 101174 | 001UF DISC | REF |
| C23 | 101068 | 330 pF DISC | 1 |
| C24 | 121092 | 0022UF/100V | REF |
| C25 | 120128 | 1 UF/100V | 3 |
| C26 | 120130 | 15UF/100V | 3 |
| C27 | 120131 | 015UF/100V | 3 |
| C28 | 120132 | 0013UF/100V | 3 |
| C29 | 120129 | 1 UF/100V | REF |
| C30 | 120130 | 15UF/100V | REF |
| C31 | 120131 | 015UF/100V | REF |
| C32 | 120132 | 0013/100V | REF |
| C33 | 120129 | 1 UF/100V | REF |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| CR1 | 211083 | [illegible] | 17 |
| CR2 | 211083 | [illegible] | REF |
| CR3 | 221177 | 1/4 W 2 4 AZ5 | 4 |
| CR4 | 221177 | 1/4 W 2/4 AZ5 | REF |
| CR5 | 211083 | 018 | REF |
| CR6 | 211083 | [illegible] | REF |
| CR7 | 211083 | [illegible] | REF |
| CR8 | 211083 | [illegible] | REF |
| CR9 | 211083 | [illegible] | REF |
| CR10 | 210004 | SD4 | 21 |
| CR11 | [illegible] | SD4 | REF |
| CR12 | [illegible] | SD4 | REF |
| CR13 | 211083 | 018 | REF |
| CR14 | 211083 | 018 | REF |
| CR15 | 211083 | 018 | REF |
| CR16 | 211083 | [illegible] | REF |
| CR17 | 211083 | 018 | REF |
| CR18 | 211083 | 018 | REF |
| CR19 | 211083 | 018 | REF |
| CR20 | 211083 | 018 | REF |
| CR21 | 221177 | 1/4W 2 4AZ5 | REF |
| CR22 | 211083 | 018 | REF |
| CR23 | 211083 | 018 | REF |
| CR24 | 221177 | 1/4W 2 4AZ5 | REF |
| CR25 | 210004 | SD4 | REF |
| CR26 | 210004 | SD4 | REF |
| CR27 | 210004 | SD4 | REF |
| CR28 | 210004 | SD4 | REF |
| CR29 | 210004 | SD4 | REF |
| CR30 | 210004 | SD4 | REF |
| CR31 | 210004 | SD4 | REF |
| CR32 | 210004 | SD4 | REF |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| Q1 | 200043 | 2N3565 | 18 |
| Q2 | 402719 | FSV ASST | REF |
| Q3 | 200622 | 012 | 4 |
| Q4 | 200043 | 2N3565 | REF |
| Q5 | 201205 | 2ND STAGE DUAL | 1 |
| Q6 | 200078 | D14 GRADED | 1 |
| Q7 | 200043 | [illegible] | REF |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| Q8 | 200043 | 2N3565 | REF |
| Q9 | 200043 | 2N3565 | REF |
| Q10 | 200078 | D14 | 7 |
| Q11 | 200043 | 2N3565 | REF |
| Q12 | 200043 | 2N3565 | REF |
| Q13 | 200043 | 2N3565 | REF |
| Q14 | 200011 | 009 | 8 |
| Q15 | 200043 | 2N3565 | REF |
| Q16 | 200022 | 012 | REF |
| Q17 | 200043 | 2N3565 | REF |
| Q18 | 200078 | D14 | REF |
| Q19 | 200011 | 009 | REF |
| Q20 | 200011 | 009 | REF |
| Q21 | 200078 | D14 | REF |
| Q22 | 200043 | 2N3565 | REF |
| Q23 | 200043 | 2N3565 | REF |
| Q24 | 200022 | 012 | REF |
| Q25 | 200022 | 012 | REF |
| Q26 | 200043 | 2N3565 | REF |
| Q27 | 200040 | 018 DUAL | 2 |
| Q28 | 200040 | 018 DUAL | REF |
| Q29 | 200035 | 014 | REF |
| Q30 | 200043 | 2N3565 | REF |
| Q31 | 200011 | 009 | REF |
| Q32 | 200043 | 2N3565 | REF |
| Q33 | 200011 | 009 | REF |
| Q34 | 200043 | 2N3565 | REF |
| Q35 | 200035 | 014 | REF |
| Q36 | 200035 | 014 | REF |
| Q37 | 200011 | 009 | REF |
| Q38 | 200011 | 009 | REF |
| Q39 | 200035 | 014 | REF |
| Q40 | 200011 | 009 | REF |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| R1 | [illegible] | 100 OHMS 3% WW | 4 |
| R2 | [illegible] | 3.0 k | 8 |
| R3 | 010111 | 1M% MFRN65C | 2 |
| R4 | [illegible] | 100 OHMS 3% WW | REF |
| R5 | 000382 | 3.9 k | REF |
| R6 | 010111 | 1M% MFRN65C | REF |
| R7 | 402719 | FSV ASST | REF |
| R8 | 020097 | 10K WW 1% | 2 |
| R9 | 020097 | 10K WW 1% | REF |
| R10 | 040093 | 500 OHM POT | 2 |
| R11 | 000821 | 820 OHMS | 1 |
| R12 | 000152 | 1.5 k | 2 |
| R13 | 000242 | 2.4 k | 1 |
| R14 | 000472 | 4.7 k | 2 |
| R15 | 020424 | 9.170 k WW 05% | 1 |
| R16 | 020423 | 3.442 k WW 05% | 1 |
| R17 | 020422 | 1.530 k WW 05% | 1 |
| R18 | 020421 | 573.7 WW .05% | 1 |
| R19 | 020420 | 281 OHMS WW 05% | 1 |
| R20 | 402719 | FSV ASST | REF |
| R21 | 020086 | 840 OHMS WW 1% | 1 |
| R22 | 402719 | FSV ASST | REF |
| R23 | 020079 | 100 k WW 1% | 2 |
| R24 | 402718 | FSV ASST | REF |
| R25 | 402719 | FSV ASST | REF |
| R26 | 020079 | 100 k WW 1% | REF |
| R27 | 402719 | FSV ASST | REF |
| R28 | 040082 | 20 k POT | 2 |
| R29 | 040082 | 20 k POT | REF |
| R30 | 011178 | 4.99 M RN60X | 2 |
| R31 | 011178 | 4.99 M RN60X | REF |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| R32 | 010130 | 8.18 k RN60D | 1 |
| R33 | 402719 | FSV ASST | REF |
| R34 | 010059 | 20 k RN60D | 2 |
| R35 | 010059 | 20 k RN60D | REF |
| R36 | 010110 | 10 k RN65C | 1 |
| R37 | 040083 | 500 OHMS POT | REF |
| R38 | 402719 | FSV ASST | REF |
| R39 | 402719 | FSV ASST | REF |
| R40 | 020078 | 50 k WW .1% | 2 |
| R41 | 020078 | 50 k WW .1% | REF |
| R42 | 020425 | 10 455 k WW .1% | 2 |
| R43 | 040108 | 50 OHMS POT | 1 |
| R44 | 020426 | 18.686 k WW .1% | REF |
| R45 | 402719 | FSV ASST | REF |
| R46 | 040026 | 1 k POT | 1 |
| R47 | 402719 | FSV ASST | REF |
| R48 | 402719 | FSV ASST | REF |
| R49 | 010020 | 4.99 k RN60D | 5 |
| R50 | 020104 | 3.75 k WW 1% | 1 |
| R51 | 010020 | 4.99 k RN60D | REF |
| R52 | 010020 | 4.99 k RN60D | REF |
| R53 | 000512 | 5.1 k | 1 |
| R54 | 000153 | 15 k | 3 |
| R55 | 000752 | 7.5 k | 2 |
| R56 | 000123 | 12 k | 2 |
| R57 | 000363 | 39 k | 4 |
| R58 | 000393 | 39 k | REF |
| R59 | 000104 | 100 k | 2 |
| R60 | 010019 | 30.1 k RN60D | 1 |
| R61 | 000153 | 15 k | REF |
| R62 | 011334 | 2.61 k RN60D | 1 |
| R63 | 010098 | 1.4 k RN60D | 1 |
| R64 | 000103 | 10 k | 6 |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| R65 | [illegible] | 10 k | REF |
| R66 | [illegible] | 220 OHMS | 2 |
| R67 | 010027 | 499 OHMS RN60D | 1 |
| R68 | 000123 | 12 k | REF |
| R69 | 000103 | 10 k | REF |
| R70 | 000204 | 200 k | 1 |
| R71 | 000221 | 220 OHMS | REF |
| R72 | 000823 | 82 k | 1 |
| R73 | 000222 | 2.2 k | 1 |
| R74 | 000153 | 15 k | REF |
| R75 | 000152 | 1.5 k | REF |
| R76 | 020118 | 886 OHMS WW 1% | 1 |
| R77 | 000822 | 8.2 k | 1 |
| R78 | 000223 | 22 k | 1 |
| R79 | 000472 | 4.7 k | REF |
| R80 | 000393 | 39 k | REF |
| R81 | 000291 | 280 OHMS | 4 |
| R82 | 000201 | 200 OHMS | REF |
| R83 | 000103 | 10 k | REF |
| R84 | 000363 | 39 k | REF |
| R85 | 000122 | 1.2 k | 2 |
| R86 | 000510 | 51 OHMS | 2 |
| R87 | 000201 | 200 OHMS | REF |
| R88 | 000201 | 200 OHMS | REF |
| R89 | 001158 | 330 OHMS 1/2W 5% | 2 |
| R90 | 001158 | 330 OHMS 1/2W 5% | REF |
| R91 | 000273 | 27 k | 1 |
| R92 | 000122 | 1.2 k | REF |
| R93 | 000510 | 51 OHMS | REF |
| R94 | 000124 | 120 k | 1 |
| R95 | 010008 | 9.53 k RN60D | 2 |
| R96 | 010020 | 4.99 k RN60D | REF |
| R97 | 010324 | 10.7 k RN60D | 1 |
| R98 | 012211 | 4.42k RN60D | 1 |
| R99 | 000822 | 8.2 k | 1 |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| R100 | [illegible] | 100 k | REF |
| R101 | 000318 | 3 k | 1 |
| R102 | 000281 | 300 OHMS | 1 |
| R103 | 000182 | 1.8 k | 1 |
| R104 | 000183 | 18 k | 1 |
| R105 | 000151 | 150 OHMS | 2 |
| R106 | 000202 | 2 k | 2 |
| R107 | 000752 | 7.5 k | 1 |
| R108 | 000103 | 10 k | REF |
| R109 | 010062 | 9.31 k RN60D | 2 |
| R110 | 040100 | 5 k POT | 1 |
| R111 | 010082 | 9.31 k RN60D | REF |
| R112 | 000202 | 2 k | REF |
| R113 | 010068 | 8.45 k RN60D | 1 |
| R114 | 011332 | 1 k RN60D | 2 |
| R115 | 010084 | 54.9 k RN60D | 1 |
| R116 | 000102 | 1 k | 2 |
| R117 | 011332 | 1 k RN60D | REF |
| R118 | 000102 | 1 k | REF |
| R119 | 010113 | 15 k RN60D | 1 |
| R120 | 000103 | 10 k | REF |
| R121 | 010020 | 4.99 k RN60D | REF |
| R122 | 010068 | 9.53 k RN60D | REF |
| R123 | 010087 | 11.5 k RN60D | 1 |
| R124 | 000392 | 3.9 k | REF |
| R125 | 000392 | 3.9 k | REF |
| R128 | 010137 | 100 OHMS RN60D | 1 |
| R127 | 000102 | 1 k | REF |
| R128 | 000471 | 470 OHMS | 1 |
| R129 | 000301 | 300 OHMS | REF |
| R130 | 040022 | 500 OHMS POT | 2 |
| R131 | 000681 | 680 OHMS | 2 |
| R132 | 000681 | 680 OHMS | REF |
| R133 | 040022 | 500 OHMS POT | REF |
| R134 | 001698 | 20 OHMS 1/2W 5% | 4 |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| R135 | [illegible] | 20 OHMS 1/2W 5% | REF |
| R136 | [illegible] | 20 OHMS 1/2W 5% | REF |
| R137 | [illegible] | 20 OHMS 1/2W 5% | REF |
| R138 | [illegible] | 10 OHMS | 3 |
| R139 | [illegible] | 3.9 k | REF |
| R140 | [illegible] | 3.9 k | REF |
| R141 | 030003 | 39 OHMS 2W 5% | 2 |
| R142 | 000100 | 10 OHMS | REF |
| R143 | [illegible] | 1.5 k 1/2W 5% | 2 |
| R144 | 000100 | 10 OHMS | REF |
| R145 | 001682 | 1.5 k 1/2W 5% | REF |
| R146 | [illegible] | 39 OHMS 2W 5% | REF |
| R147 | 000151 | 150 OHMS | REF |
| R148 | 020106 | 100 OHMS WW 3% | REF |
| R149 | 020106 | 100 OHMS WW 3% | REF |
| R150 | [illegible] | 100 OHMS | 1 |
| T1 | 300021 | TRANSFORMER | 1 |

| REF DES OR ITEM | P/N | DESCRIPTION | QTY |
|---|---|---|---|
| | 402719 | FSV ASSY | 1 |
| | 410350 | PCB AMPL 100M OP R VARIABLE | 1 |
| | [illegible] | ANTHONY AMPL 100M OP W VARI | REF |
| | 430441 | SCHEMATIC AMPL V2 | REF |
| | [illegible] | INSULATOR | 2 |
| | 452201 | BRACKET-SUPPORT | 1 |
| | 452292 | [illegible] | 1 |
| | 452295 | [illegible] | 1 |
| | 452296 | COVER ELEC SHLD | 1 |
| | [illegible] | [illegible] | 1 |
| | 452298 | SHIELD-ELECSTAT | 1 |
| | 452343 | CASE MODIFIED HB0256 HYBLASS | 2 |
| | 452305 | INSULATOR | 1 |
| | 452725 | CLIP COMP 560 DIA MTG | 2 |
| | 452726 | CLIP COMP 800 DIA MTG | 2 |
| | 452723 | STANDOFF COMP. SUPPORT | 22 |
| | [illegible] | TUBING SHRINK .153 I.D. | A/R |
| | 500004 | WIRE BUSS 22 GA | A/R |
| | 500005 | NYLON TIE CORD | A/R |
| | [illegible] | CABLE STORW | A/R |
| | 500043 | B24-10/30M-32V | A/R |
| | [illegible] | [illegible] | A/R |
| | 524000 | WIRE-24GA STR 0 COLOR | A/R |
| | 524208 | WIRE 24GA STR 2-0-5 COLOR | A/R |
| | 524215 | WIRE 24GA STR 2-1-5 | A/R |
| | 524728 | WIRE 24GA STR 7-2-8 COLOR | A/R |
| | 524088 | WIRE 24GA STR 0-8-8 COLOR | A/R |
| | 524698 | WIRE 24GA STR 0-9-8 COLOR | A/R |
| | 524910 | WIRE 24GA STR 0-1-0 COLOR | A/R |
| | 524911 | WIRE-24 GA STR 0-1-1 COLOR | A/R |
| | [illegible] | WIRE-24 GA STR 0-1-2 COLOR | A/R |
| | 524913 | WIRE-24 GA STR 0-1-3 COLOR | A/R |
| | 524914 | WIRE-24 GA STR 0-1-4 COLOR | A/R |
| | 524915 | WIRE-24 GA STR 0-1-5 COLOR | A/R |
| | 524916 | WIRE-24 GA STR 0-1-6 COLOR | A/R |
| | 524917 | WIRE-24 GA STR 0-1-7 COLOR | A/R |
| | 524918 | WIRE-24 GA STR 0-1-8 COLOR | A/R |

| REVISIONS | | | |
|---|---|---|---|
| LTR | DESCRIPTION | DR | CHK | APPD |
| | SEE SHEET 1 | | | |

| P/N | DESCRIPTION | QTY |
|---|---|---|
| 524919 | WIRE 24GA STR 0-1-9 COLOR | A/R |
| 524920 | WIRE-24 GA STR 0-2-0 COLOR | A/R |
| 524921 | WIRE-24 GA STR 0-2-1 COLOR | A/R |
| 524922 | WIRE-24 GA STR 0-2-2 COLOR | A/R |
| [illegible] | WIRE-24 GA STR 0-2-3 COLOR | A/R |
| [illegible] | WIRE-24 GA STR 0-2-4 COLOR | A/R |
| 524925 | WIRE-24 GA STR 0-2-5 COLOR | A/R |
| 524926 | WIRE-24 GA STR 0-2-6 COLOR | A/R |
| 524927 | WIRE-24 GA STR 0-2-7 COLOR | A/R |
| 524928 | WIRE-24 GA STR 0-2-8 COLOR | A/R |
| 524929 | WIRE 24GA STR 0-2-9 COLOR | A/R |
| 524939 | WIRE 24GA STR 0-3-9 COLOR | A/R |
| 524999 | WIRE 24GA STR 0-9-9 COLOR | A/R |
| 800016 | HEAT SINK IERC TX0F-032-0258 | 2 |
| 800032 | LUG-SOLDER | 1 |
| 800068 | IERC LPS038 HEAT DISS | 2 |
| 800245 | JUMPER-INSUL [illegible] | 4 |
| 800277 | SWITCH ROT 2 POL 8 POS | 1 |
| 800278 | SWITCH ROTARY 3 POL, 10 POS | 1 |
| 800295 | [illegible] | 1 |
| 800297 | CONN-PC JACK CARDLOK-3304-2-00 | 10 |
| 800344 | CONN 8 PINS AMPH 26-4101-8P | 1 |
| 810019 | RIVET-1/8 SEMI-TUB X 5/32 LG | 8 |
| [illegible] | GROMMET RUB 1/4 I.D. X 3/8 | 1 |
| 810101 | NUT-PRESS 8-32 PEM S-832-1 | 8 |
| 810111 | NUT-PRESS, 4-40, PEM S-440-1 | 8 |
| 810127 | WASH-SHIELD, NYL, W LOCK | 2 |
| [illegible] | # 4 NYLON WASHER | 4 |
| 810292 | STDOFF-SW 4-40 X 1/8 LG (/40 00 MTG | 2 |
| 810275 | CLAMP CABLE PL. [illegible] | 4 |

| P/N | DESCRIPTION | QTY |
|---|---|---|
| 810818 | SCREW PPH 2-56 X 5/16 STLS | 4 |
| 810843 | SCREW PPH 4-40 X 5/16 STLS | 8 |
| 810844 | SCREW PPH 4-40 X 3/8 STLS | 4 |
| 810847 | SCREW PPH 4-40X 5/8 STLS | 2 |
| 810858 | SCREW PPH 6-32 X 5/16 STLS | 8 |
| 810940 | SCREW PPH 4-40 X 3/16 STLS | 2 |
| 817004 | HEX NUT 4-40 STD STLS | 4 |
| 817014 | [illegible] | 4 |
| 817018 | HEX NUT 4-40 [illegible] | 2 |
| 817075 | [illegible] 2 STLS | 4 |

| P/N | DESCRIPTION | QTY |
|---|---|---|
| 813077 | WASHER INT LOCK 4 STLS | 15 |
| 817079 | WASHER INT LOCK 6 STLS | 8 |
| 817102 | WASHER-FLAT,LIGHT SERIES 4 STLS | 2 |
| 820006 | TRANS PAD-LARGE | 12 |
| 820010 | SOLDER BAR | [illegible] |
| 820026 | SOLDER WIRE 63/37 RESIN CORE | A/R |
| 820056 | PLUG PLASTEX 20T-000343-0000100 | 2 |
| 820083 | TRANS PAD ROSS 10037 | AR |
| 820271 | CAP ENCAPSULATING HYBLASS #4 BLK | 2 |

| QTY REQD | * DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|
| | | LIST OF MATERIAL OR PARTS LIST | | | |

| NEXT ASSY | USED ON | REF | REF |
|---|---|---|---|
| APPLICATION | | QTY REQD | NA | FA |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS ANGLES .X ±.030 .XX ±.010 .XXX ±.005 0° 30' FORMED ANGLES 1.0
MATERIAL
FINISH
CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

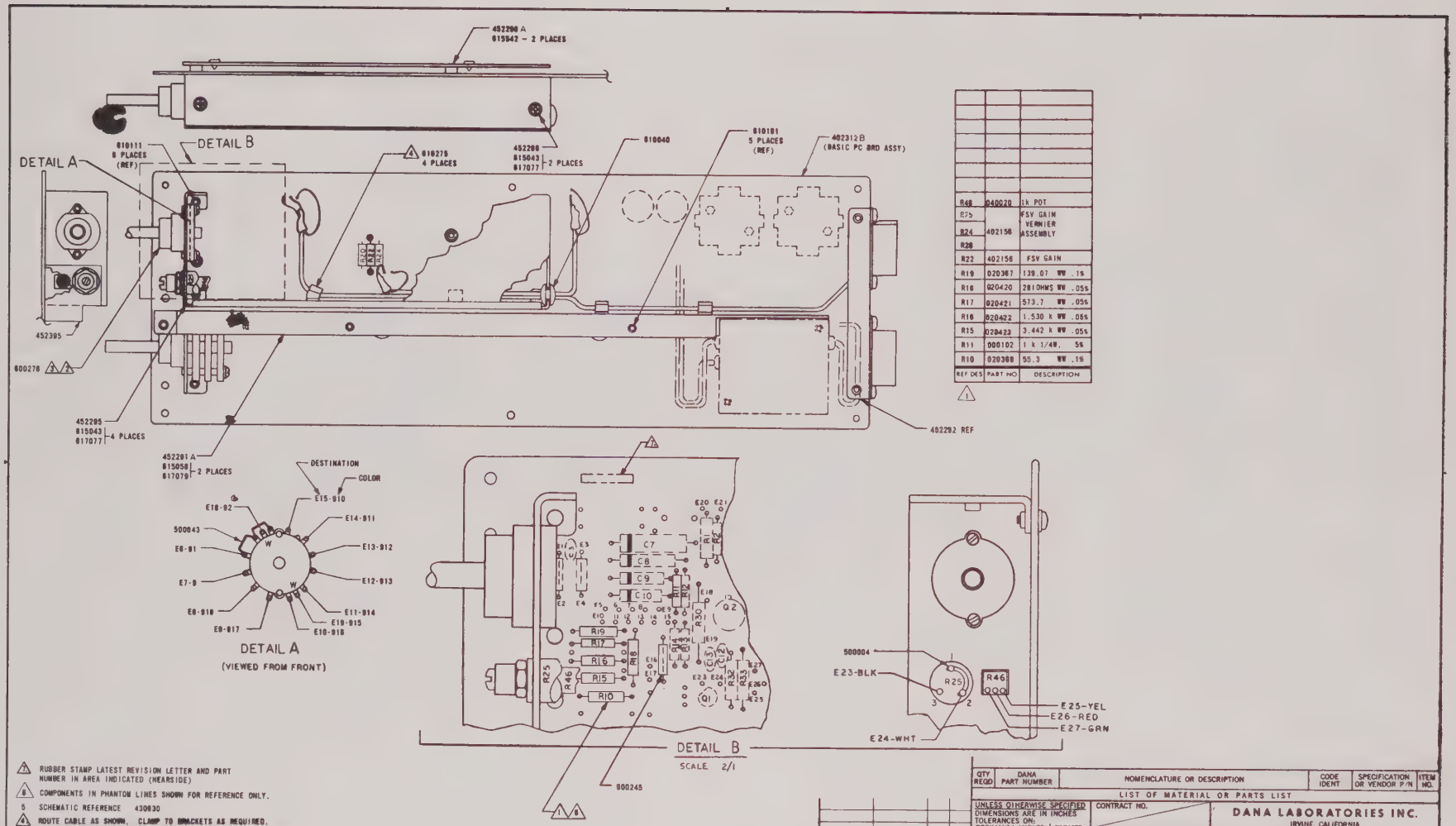
| | |
|---|---|
| DRAWN | |
| CHECK | |
| DESIGN | |
| PROJ ENGR | |

PCB ASSY-
MODEL 2850 V2

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 402311 | |

SCALE NONE WT SHEET 5 OF 6

NOTE: UNLESS OTHERWISE SPECIFIED




| REF DES | PART NO | DESCRIPTION |
|---|---|---|
| R46 | 040020 | 1k POT |
| R25 | | FSV GAIN VERNIER ASSEMBLY |
| R24 | 402158 | |
| R28 | | |
| R22 | 402158 | FSV GAIN |
| R19 | 020367 | 139.07 WW .1% |
| R16 | 020420 | 281 OHMS WW .05% |
| R17 | 020421 | 573.7 WW .05% |
| R18 | 020422 | 1.530 k WW .05% |
| R15 | 020423 | 3.442 k WW .05% |
| R11 | 000102 | 1 k 1/4W. 5% |
| R10 | 020369 | 55.3 WW .1% |

1. RUBBER STAMP LATEST REVISION LETTER AND PART NUMBER IN AREA INDICATED (NEARSIDE)
2. COMPONENTS IN PHANTOM LINES SHOWN FOR REFERENCE ONLY.
3. SCHEMATIC REFERENCE 430830
4. ROUTE CABLE AS SHOWN, CLAMP TO BRACKETS AS REQUIRED.
5. COAT AREA WITH NUMI-SEAL AS REQUIRED AVOIDING BRACKET MOUNTING HOLES. MOUNT BRACKET TO PC BOARD.
6. MOUNT SWITCH, R25 & R46 TO BRACKET-WIRE PER DETAIL "A". WIRING ON SWITCH SHOULD ROLL OFF ONE SIDE, KEEPING WIRE LENGTH TO A MINIMUM.
7. ADD OPTIONAL COMPONENTS PER DANA WORKMANSHIP STANDARDS.

NOTE: UNLESS OTHERWISE SPECIFIED

| 402381 | 2050-V3 | 1 | 1 |
|---|---|---|---|
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS X .030 XX .020 XXX .010 ANGLES 0° 30' FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN J. Nash 5-1-67

CHECK R. Malone 5-1-67

ENGR

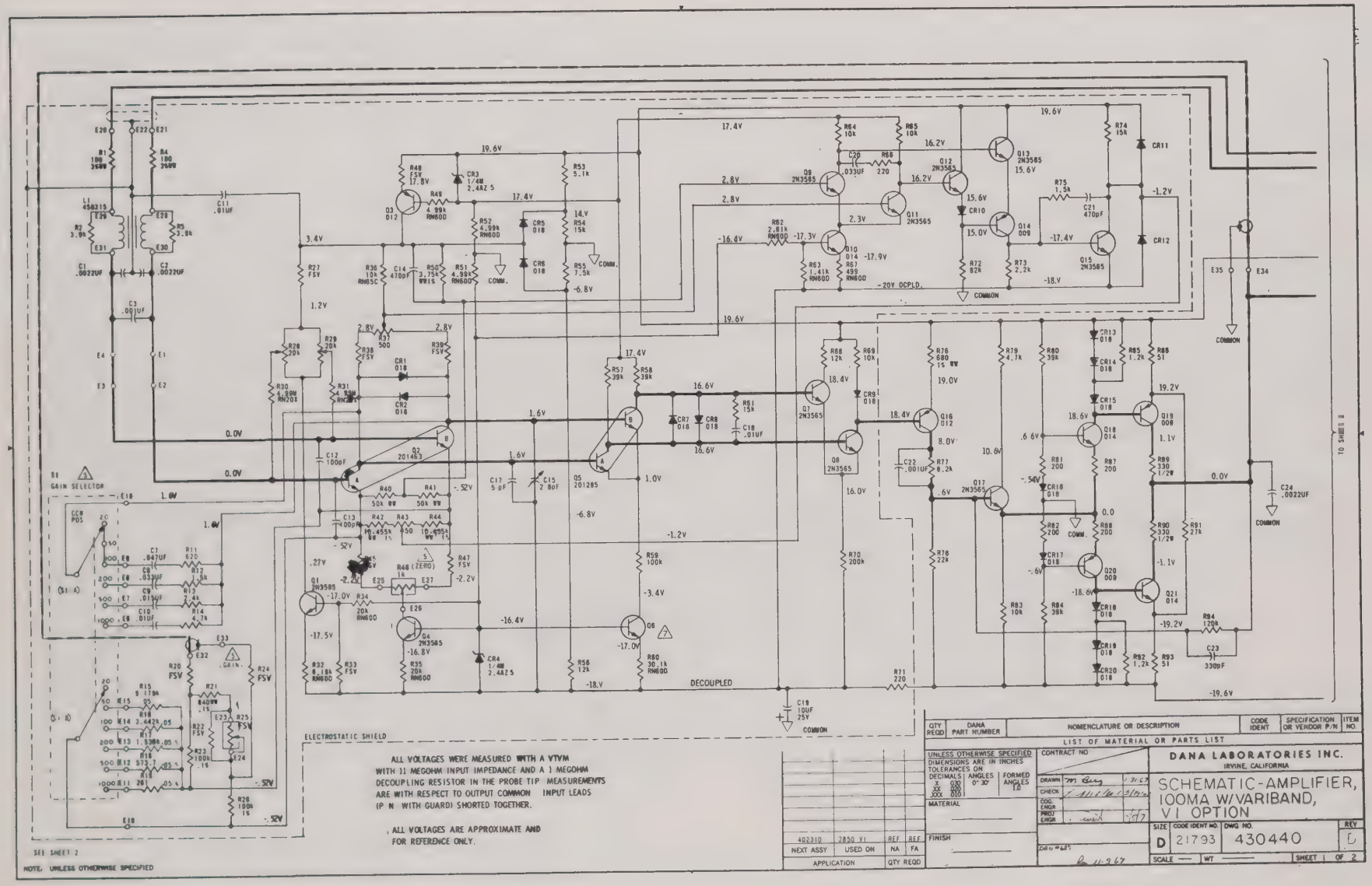
PROJ ENGR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C. BOARD ASSY-AMP, 100 MA O.P. W/VARIBAND V3 OPTION

| SIZE | CODE IDENT NO. | DWG. NO. | REV |
|---|---|---|---|
| D | 21703 | 402392 | D |

SCALE 1/1 WT SHEET 1 OF 1


GAIN SELECTOR
ELECTROSTATIC SHIELD
DECOUPLED
COMMON
TO SHEET II
SEE SHEET 2
ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P N WITH GUARD) SHORTED TOGETHER.
, ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.
NOTE: UNLESS OTHERWISE SPECIFIED

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

| | | | |
|---|---|---|---|
| 402310 | 2850 V1 | REF | REF |
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON DECIMALS: X .030, XX .020, XXX .010. ANGLES: FORMED 0° 30', ANGLES 1/2°. MATERIAL. FINISH.

CONTRACT NO.

DRAWN [illegible] 11-67

CHECK [illegible] 11-14-67

COG ENGR

PROJ ENGR [illegible] 11-67

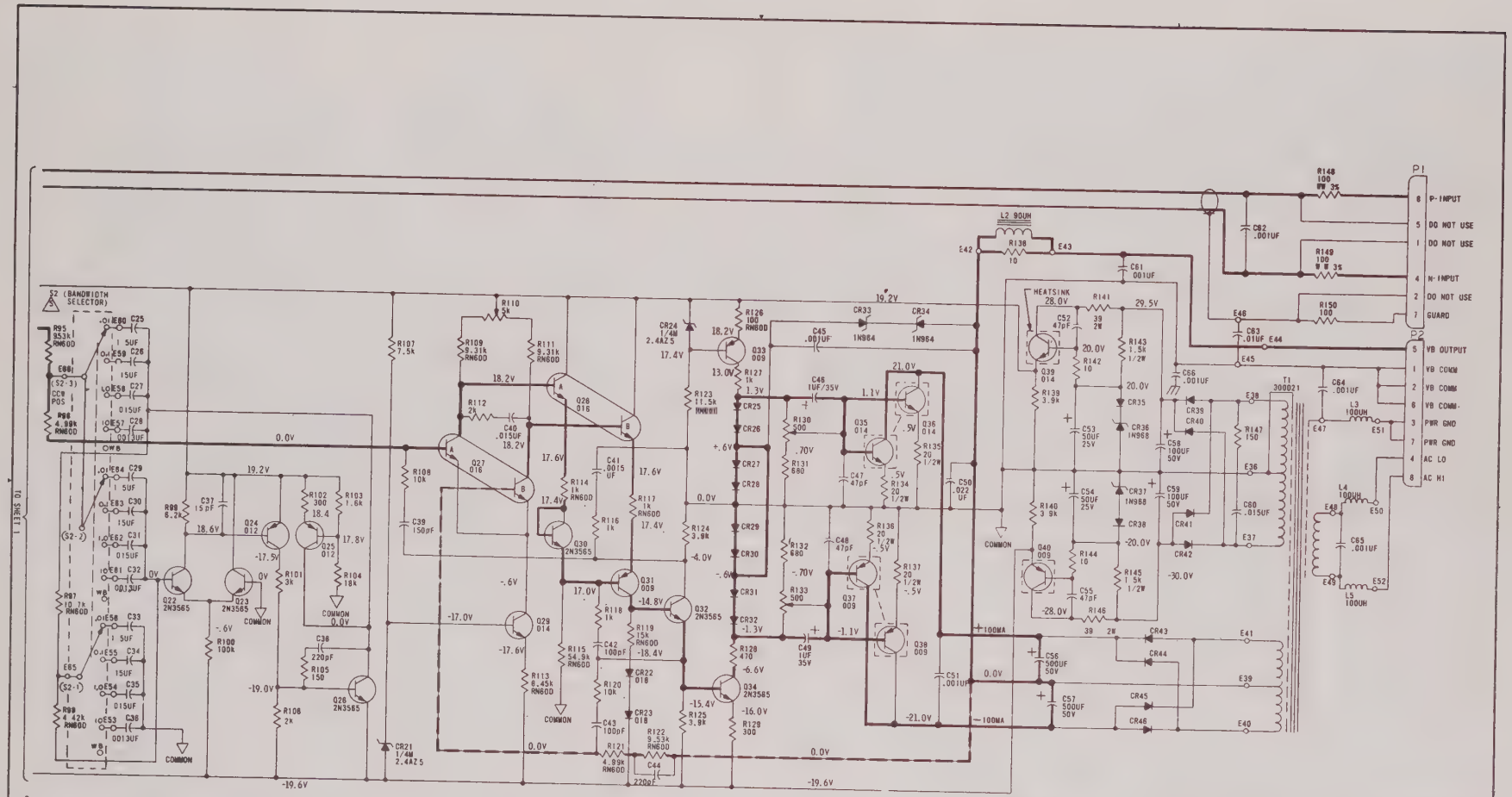
Date 11-9-67

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100MA W/VARIBAND, V1 OPTION

| SIZE | CODE IDENT NO. | DWG. NO. | REV |
|---|---|---|---|
| D | 21793 | 430440 | D |

SCALE — WT — SHEET 1 OF 2




⚠ TRANSISTOR Q7 IS A SELECTED D14 TRANSISTOR. (P/N 200078)

8. "E" NUMBERS DENOTE EYELETS AND CORRESPOND TO POINTS ON PC BRD SEE ASSY DWGS #402312 (BASIC BRD ASSY) AND 402311 (BRD ASSY W/OPTION ADDED)

⚠ R25(GAIN), R46(ZERO), S1(GAIN SELECTOR) AND S2(BANDWIDTH SELECTOR) ARE FRONT PANEL ADJUSTMENT

4. REFERENCE C16 NOT USED

3. HIGHEST REFERENCE DESIGNATORS USED: C88, CR40, L5, Q40, R150

2. ALL DIODES ARE 5B4.

1. ALL RESISTORS ARE IN OHMS, 1/4W ± 5%, CARBON.

NOTE: UNLESS OTHERWISE SPECIFIED

ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. AND GUARD) SHORTED TOGETHER.

ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

| | | | |
|---|---|---|---|
| 402310 | 2850 V1 | REF | REF |
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS ANGLES .X .030 0° 30' .XX .010 .XXX .005 FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

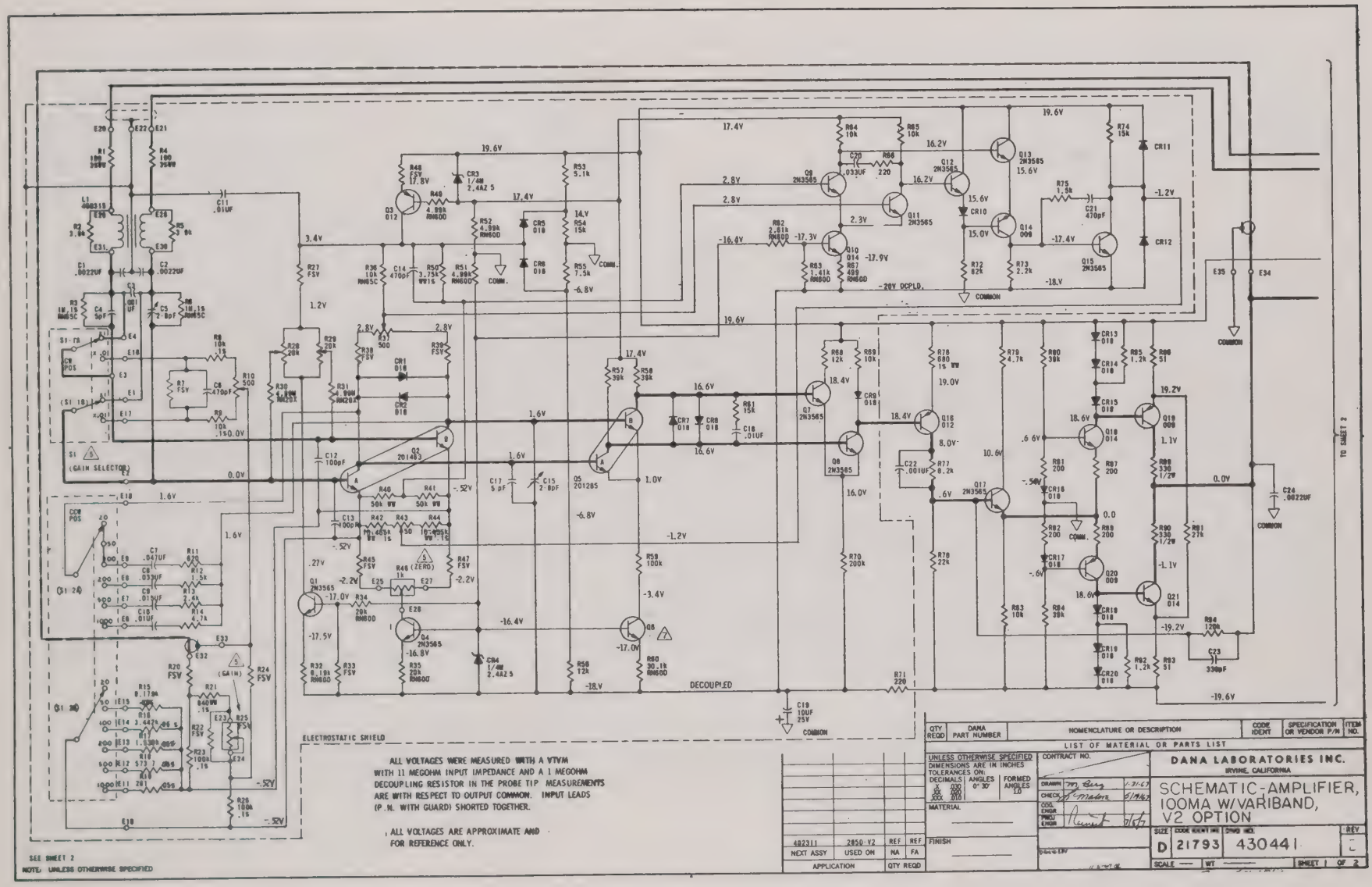
| | | |
|---|---|---|
| DRAWN | W. Berg | 11-3-67 |
| CHECK | Hill Jr. | 11-6-67 |
| COG ENGR | | |
| PROJ ENGR | | 11/6/67 |

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100MA O.P. W/VARIBAND, V1 OPTION

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430440 | |

SCALE — WT — SHEET 2 OF 2


ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. WITH GUARD) SHORTED TOGETHER.
ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.
ELECTROSTATIC SHIELD
DECOUPLED
COMMON
(GAIN SELECTOR)
(GAIN)
(ZERO)
SEE SHEET 2
NOTE: UNLESS OTHERWISE SPECIFIED
TO SHEET 2

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .XX ±.010, .XXX ±.005; ANGLES 0° 30'; FORMED ANGLES 1.0
MATERIAL
FINISH
CONTRACT NO.

| | | | |
|---|---|---|---|
| DRAWN | | | |
| CHECK | | | |
| ENGR | | | |
| PROJ ENGR | | | |

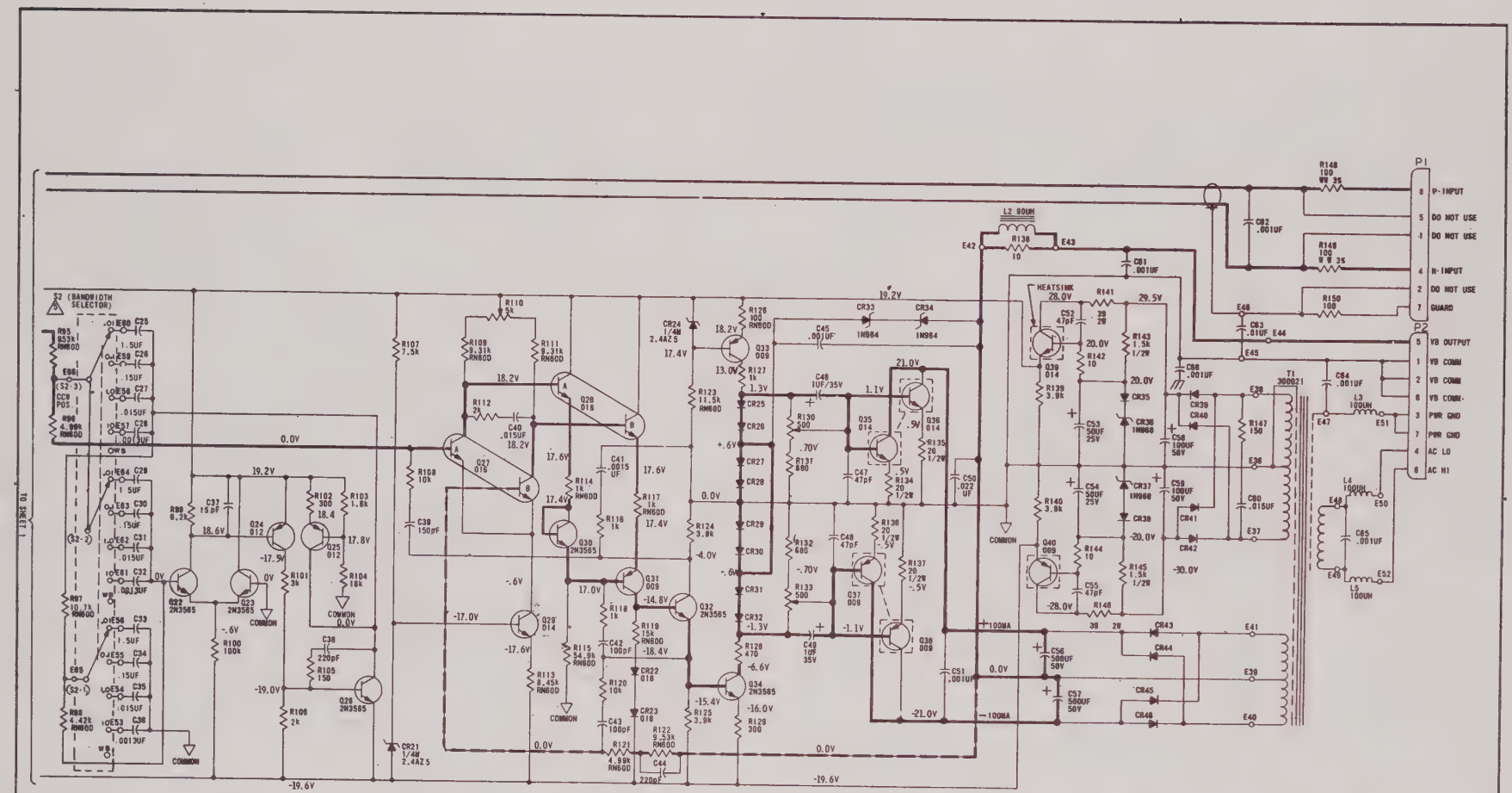
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100MA W/VARIBAND, V2 OPTION

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430441 | |

SCALE — WT — SHEET 1 OF 2

| 402311 | 2850-V2 | REF | REF |
|---|---|---|---|
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |




⚠1 TRANSISTOR Q7 IS A SELECTED 014 TRANSISTOR. (P/N 200078)

8. "E" NUMBERS DENOTE EYELETS AND CORRESPOND TO POINTS ON PC BRD. SEE ASSY DWGS #402312 (BASIC BRD ASSY) AND 402311 (OHMS ASSY W/OPTION ADDED).

⚠5 R25(GAIN), R46(ZERO), S1(GAIN SELECTOR) AND S2(BANDWIDTH SELECTOR) ARE FRONT PANEL ADJUSTMENT.

4. REFERENCE: C18 NOT USED.

3. HIGHEST REFERENCE DESIGNATORS USED: C88, CR48, L5, Q40, R156

2. ALL DIODES ARE 1N4.

1. ALL RESISTORS ARE IN OHMS, 1/4W ± 5%, CARBON.

NOTE: UNLESS OTHERWISE SPECIFIED

ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. AND GUARD) SHORTED TOGETHER.

ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.

| 402311 | 2850-V2 | REF | REF |
|---|---|---|---|
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .XX ±.02 .XXX ±.010 ANGLES 0° 30' FORMED ANGLES ±1°
MATERIAL
FINISH

CONTRACT NO.

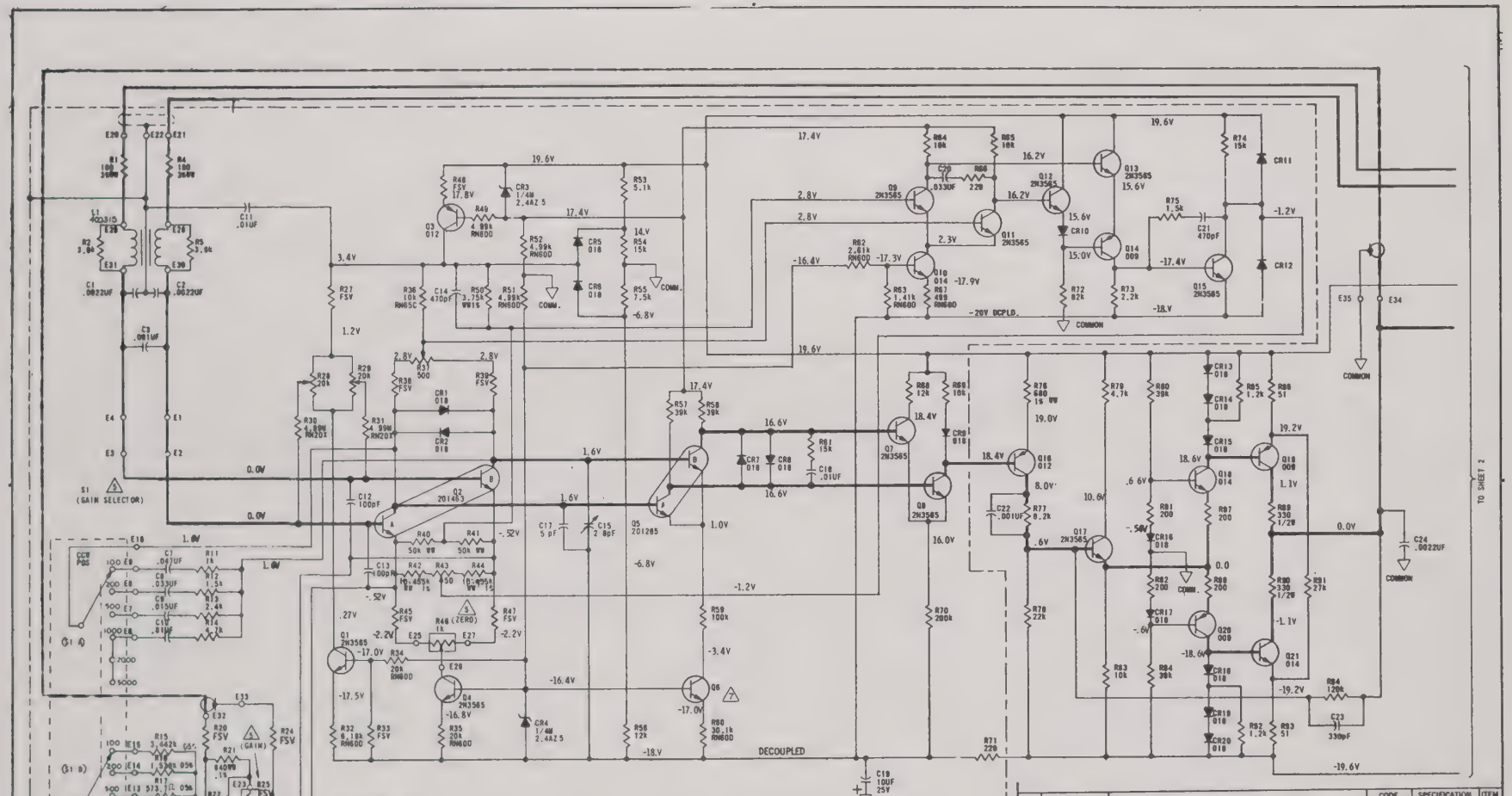
| | | |
|---|---|---|
| DRAWN | M. Berg | 1-31-67 |
| CHECK | W. Malone | 2/14/67 |
| ENGR | | |
| ENGR | | 7/5/67 |

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100 MA O.P. W/VARIBAND, V2 OPTION

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430441 | |

SCALE — WT — SHEET 2 OF 2


ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. WITH GUARD) SHORTED TOGETHER.
ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.
S1 (GAIN SELECTOR)
ELECTROSTATIC SHIELD
DECOUPLED
COMMON
-20V DCPLD.
TO SHEET 2
SEE SHEET 2
NOTE: UNLESS OTHERWISE SPECIFIED

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

| | | | | | |
|---|---|---|---|---|---|
| 4C3058 | 2850-V3 | REF | REF | FINISH | |
| NEXT ASSY | USED ON | MA | FA | | |
| APPLICATION | | QTY REQD | | | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .XX .010, .XXX .005, .XXXX .0010; ANGLES 0° 30'; FORMED ANGLES ±1°. MATERIAL

CONTRACT NO.

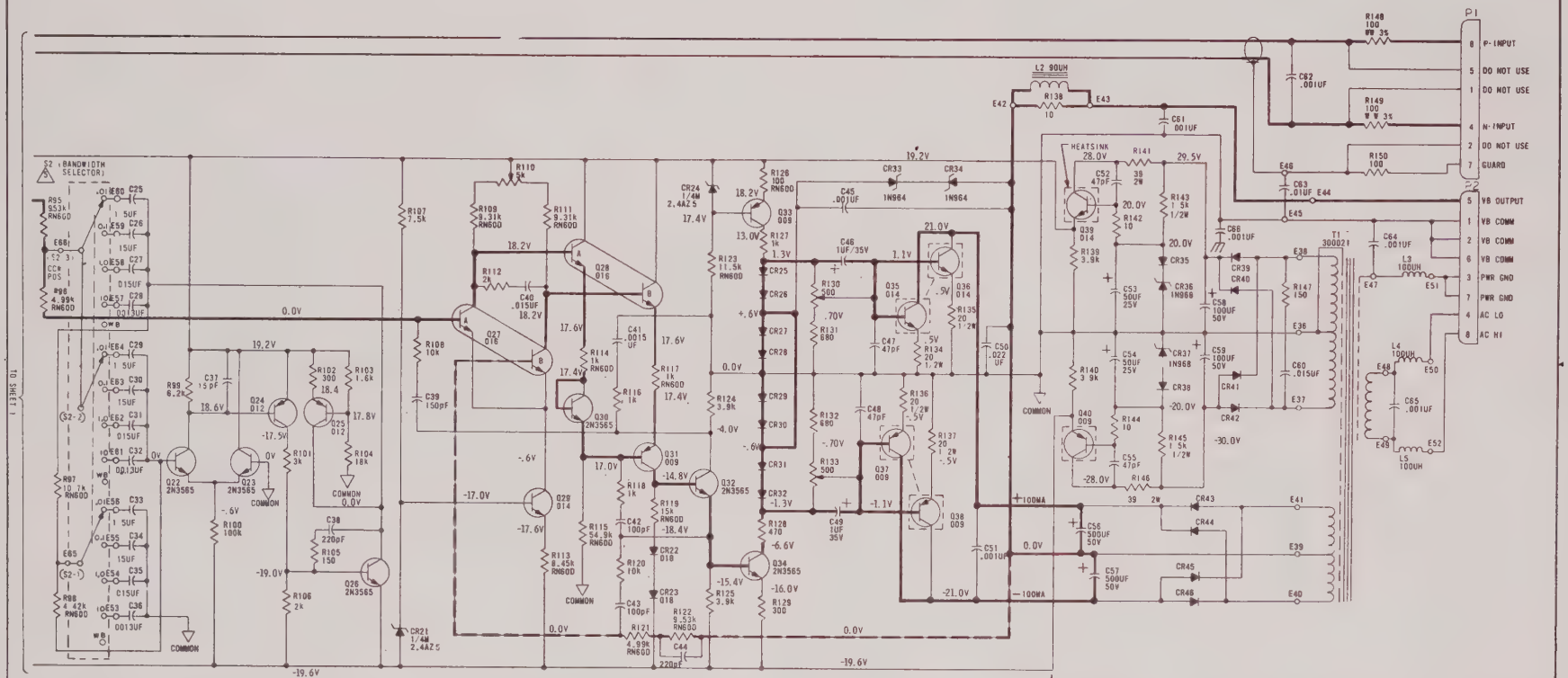
DRAWN W. Berg 1-21-67
CHECK [illegible] 1-19-67
COG. ENGR
PROJ. ENGR [illegible] 1-19-67

**DANA LABORATORIES INC.**
IRVINE, CALIFORNIA

# SCHEMATIC-AMPLIFIER, 100 MA O.P. W/VARIBAND, V3 OPTION

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430630 | E |

SCALE — WT — SHEET 1 OF 2




1. ALL RESISTORS ARE IN OHMS 1 4W ± 5% CARBON
2. ALL DIODES ARE SD4.
3. HIGHEST REFERENCE DESIGNATORS USED C66, CR40, L5, Q40, R150
4. REFERENCE C18 NOT USED
5. R25(GAIN) R45(ZERO) S1(GAIN SELECTOR) AND S2(BANDWIDTH SELECTOR) ARE FRONT PANEL ADJUSTMENT
6. "E" NUMBERS DENOTE EYELETS AND CORRESPOND TO POINTS ON PC BRD SEE ASSY DWGS 402312 (BASIC BRD ASSY) AND 402311 (BRD ASSY W OPTION ADDED)
7. TRANSISTOR Q7 IS A SELECTED D14 TRANSISTOR (P N 200078)

NOTE. UNLESS OTHERWISE SPECIFIED

ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. AND GUARD) SHORTED TOGETHER.

ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS X .030, XX .010, XXX .005; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL —

FINISH —

CONTRACT NO.

DRAWN

CHECK

COG ENGR

PROJ ENGR

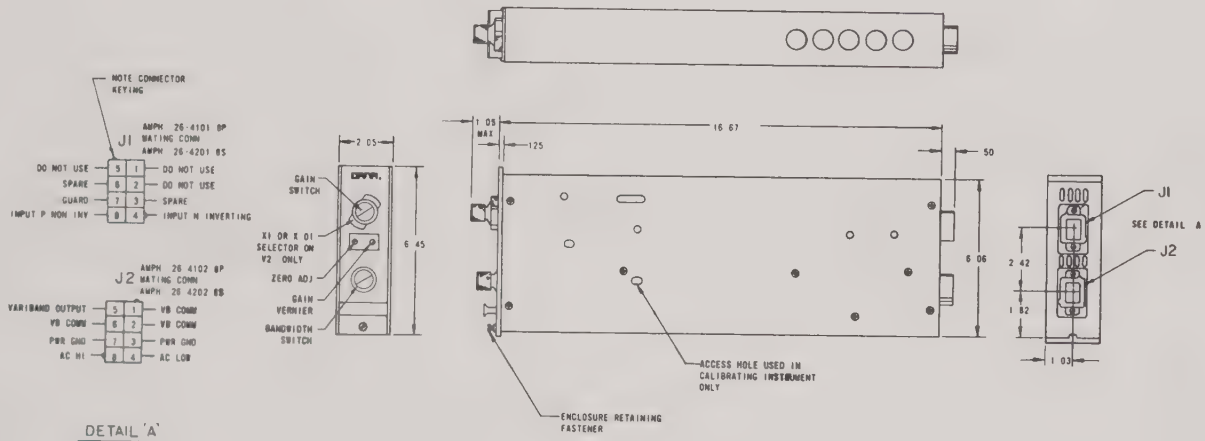
**DANA LABORATORIES INC.**
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100 MA O.P. W/VARIBAND, V3 OPTION

| SIZE | CODE IDENT NO | DWG NO | REV |
|---|---|---|---|
| D | 2793 | 430630 | E |

SCALE — WT — SHEET 2 OF 2

| 402053 | 2850 V3 | REF | REF |
|---|---|---|---|
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |




DETAIL 'A'

WIRING TYPICAL OF DANA CORD SET NO 402488 AND DANA MODEL 2008 1 & 2008-2 ENCLOSURE

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|
| 402391 | 2850 V3 | REF | REF | | |
| 402308 | 2850 V2 | REF | REF | | |
| 402307 | 2820 V1 | REF | REF | | |
| NEXT ASSY | USED ON | NA | FA | | |
| APPLICATION | | QTY REQD | | | |

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS X .030, XX .010, XXX .005; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN G. WILSON 12/4/67

CHECK V.E. Sallee 12/20/67

DES. ENGR

PROJ ENGR Bernard Stolz

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

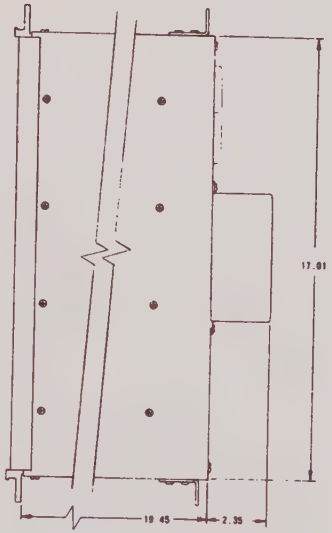
OUTLINE DIMENSIONAL
AMPLIFIER MODEL 2850

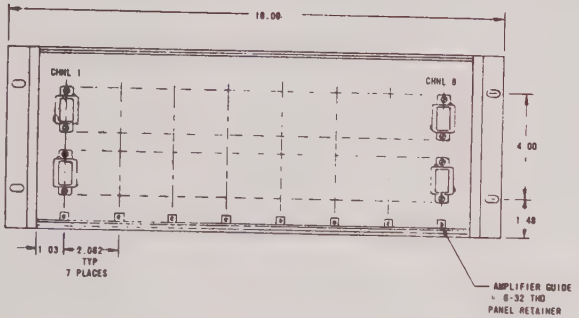
| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 452401 | A |

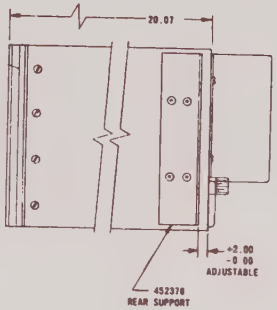
SCALE 1/8 WT SHEET 1 OF 1

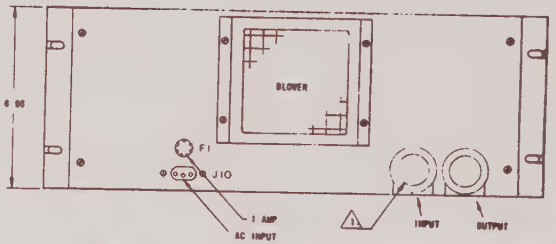
1. OUTLINE TYPICAL FOR 2850 OPTIONS V1, V2, & V3

NOTE. UNLESS OTHERWISE SPECIFIED




⚠ ENCLOSURE WIRING PER DANA DRAWING # 430590

NOTE: UNLESS OTHERWISE SPECIFIED

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|
| | | LIST OF MATERIAL OR PARTS LIST | | | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: .X ±.030, .XX ±.010, .XXX ±.005
ANGLES: 0° 30'
FORMED ANGLES ±1°

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DRAWN G WILSON 8/2/67
CHECK
ENGR APPD
PROJ ENGR 6/5/67

MATERIAL

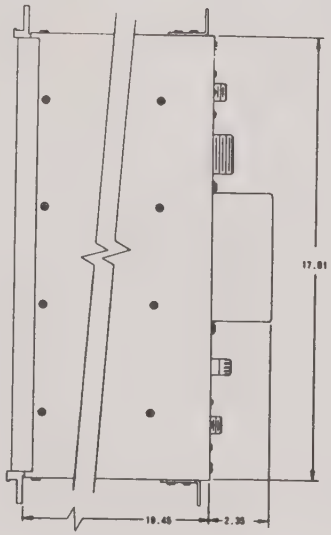
FINISH

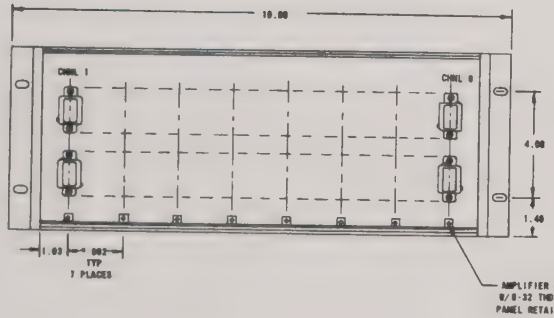
OUTLINE DIMENSIONAL
ENCLOSURE
MODEL 2808-1

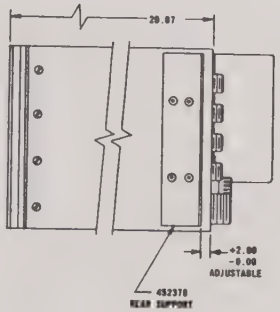
| 402368 | 2808-1 | REF | REF |
|---|---|---|---|
| NEXT ASSY | USED ON | MA | FA |
| APPLICATION | | QTY REQD | |

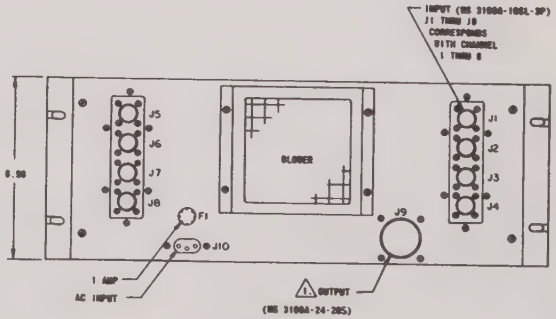
SIZE D | CAGE IDENT NO. 21793 | DWG NO. 452402

SCALE 1/2




| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|
| | | LIST OF MATERIAL OR PARTS LIST | | | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: .XX ±.03, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES 1.0

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

| | | |
|---|---|---|
| DRAWN | G WILSON | 6/26/67 |
| CHECK | | |
| COST ENGR | | |
| PROJ ENGR | | 6/26/67 |

MATERIAL

FINISH

OUTLINE DIMENSIONAL
ENCLOSURE
MODEL 2808-2

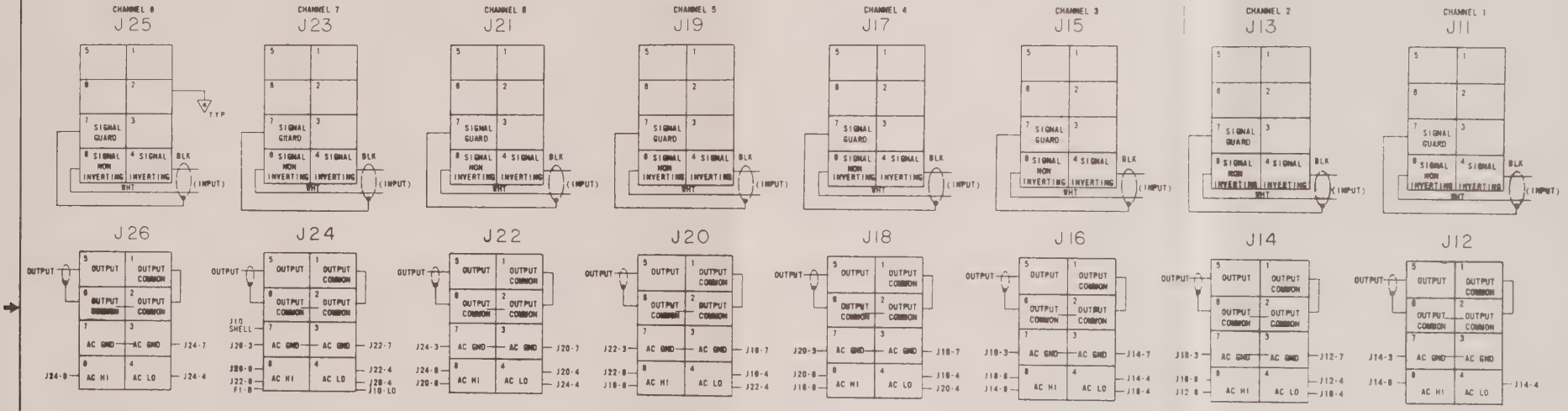
| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 452403 | |

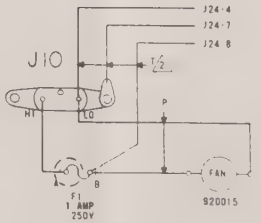
SCALE 1/2 | WT | SHEET 1 OF 1

| | | | |
|---|---|---|---|
| 402371 | 2808-2 | REF | REF |
| NEXT ASSY | USED ON | NA | FA |
| APPLICATION | | QTY REQD | |

⚠1. ENCLOSURE WIRING PER DANA DRAWING # 430901.

NOTE: UNLESS OTHERWISE SPECIFIED




| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

▽ PIN 2 TIED TO GROUND LUG MOUNTED ON CONNECTORS J11, 13, 15, 17, 19, 21, 23 AND J25 USING [illegible] WIRE.

3. INTERCONNECTIONS ON CONNECTORS USING 860864 WIRE AND 501378 SLEEVING AS REQUIRED.

△ ALL AC POWER WIRING TO BE TWISTED

1. WIRE PER DANA WORKMANSHIP AND PROCEDURE STANDARDS

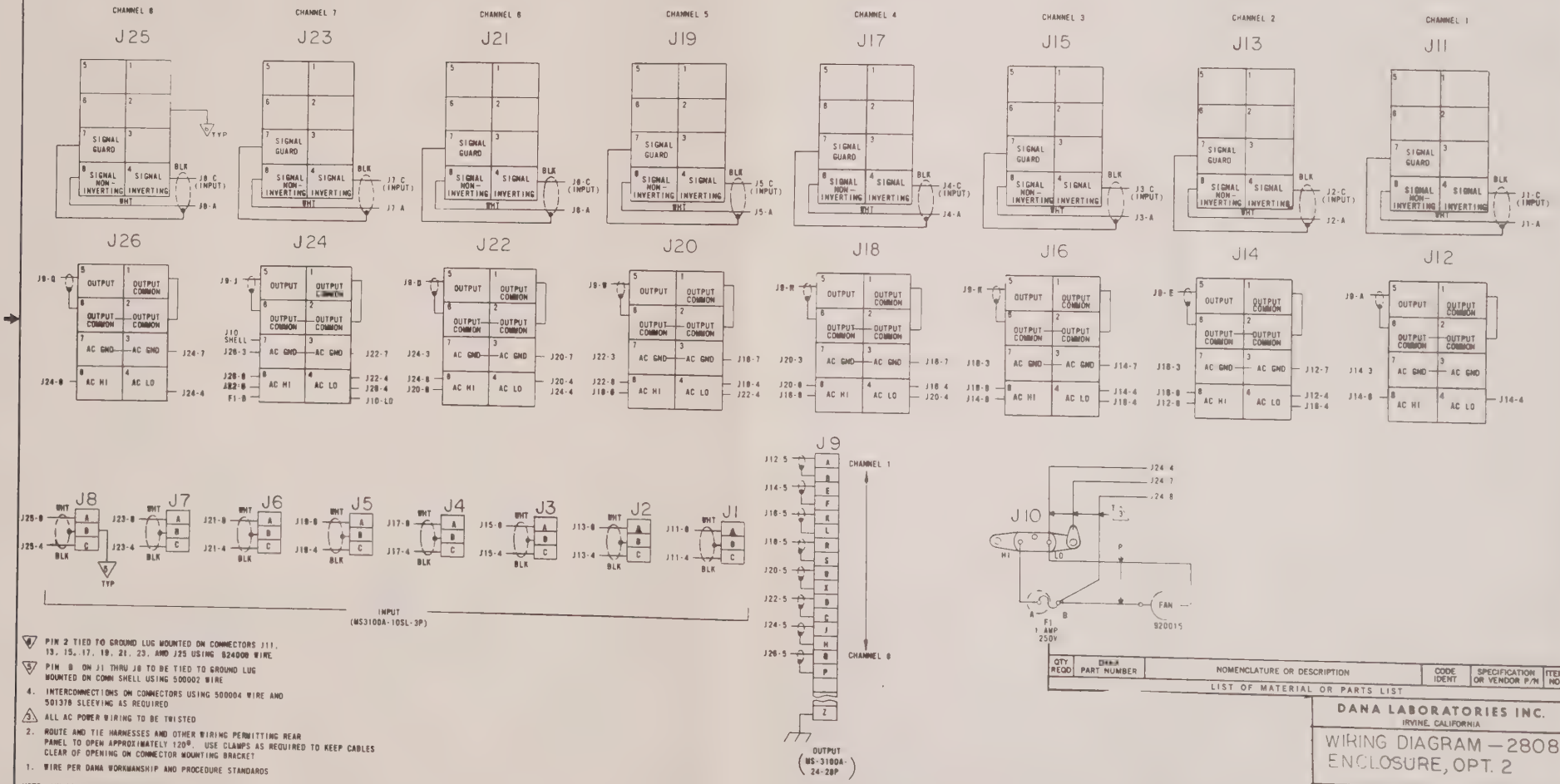
NOTE: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

WIRING DIAGRAM — 2808 ENCLOSURE; OPT 1

| SIZE | DODE IDENT NO | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430590 | C |

SCALE NONE | WT | SHEET 1 OF 2




| QTY REQD | PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

1. WIRE PER DANA WORKMANSHIP AND PROCEDURE STANDARDS
2. ROUTE AND TIE HARNESSES AND OTHER WIRING PERMITTING REAR PANEL TO OPEN APPROXIMATELY 120°. USE CLAMPS AS REQUIRED TO KEEP CABLES CLEAR OF OPENING ON CONNECTOR MOUNTING BRACKET
3. ALL AC POWER WIRING TO BE TWISTED
4. INTERCONNECTIONS ON CONNECTORS USING 500004 WIRE AND 501378 SLEEVING AS REQUIRED
5. PIN B ON J1 THRU J8 TO BE TIED TO GROUND LUG MOUNTED ON CONN SHELL USING 500002 WIRE
6. PIN 2 TIED TO GROUND LUG MOUNTED ON CONNECTORS J11, 13, 15, 17, 19, 21, 23, AND J25 USING 824008 WIRE

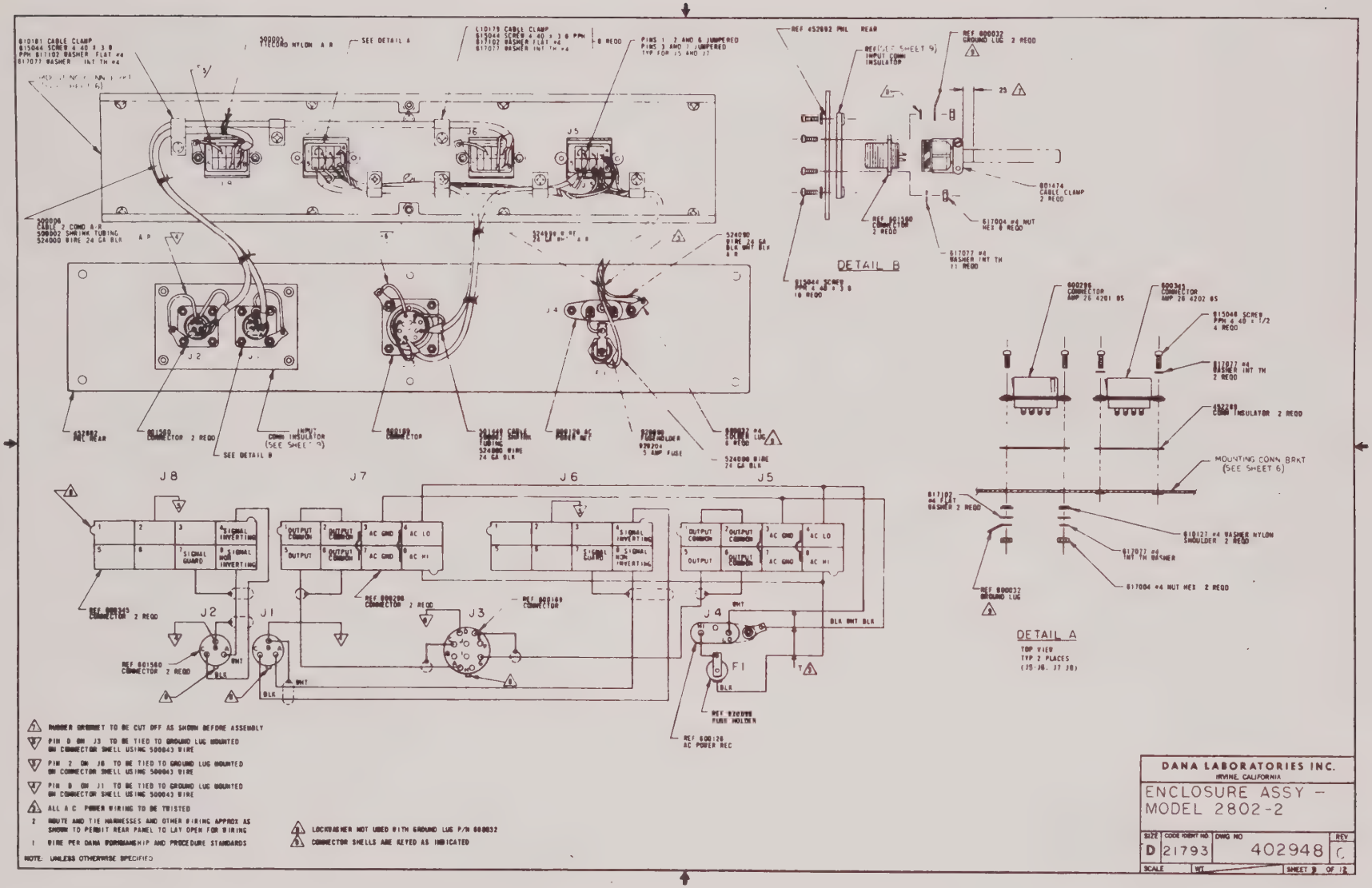
NOTE: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

# WIRING DIAGRAM — 2808 ENCLOSURE, OPT. 2

| SIZE | CODE IDENT NO. | DWG NO. | REV. |
|---|---|---|---|
| D | 21793 | 430591 | C |

SCALE NONE | WT. | SHEET 1 OF 1


DETAIL B
DETAIL A
TOP VIEW
TYP 2 PLACES
(J5 J6 J7 J8)
J8
J7
J6
J5
J2
J1
J3
J4
F1
MOUNTING CONN BRKT
(SEE SHEET 6)
INPUT CONN INSULATOR
(SEE SHEET 9)
SEE DETAIL A
SEE DETAIL B
REF 800128
AC POWER REC
1 RUBBER GROMMET TO BE CUT OFF AS SHOWN BEFORE ASSEMBLY
2 PIN D ON J3 TO BE TIED TO GROUND LUG MOUNTED ON CONNECTOR SHELL USING 500043 WIRE
3 PIN 2 ON J8 TO BE TIED TO GROUND LUG MOUNTED ON CONNECTOR SHELL USING 500043 WIRE
4 PIN D ON J1 TO BE TIED TO GROUND LUG MOUNTED ON CONNECTOR SHELL USING 500043 WIRE
5 ALL A C POWER WIRING TO BE TWISTED
6 ROUTE AND TIE HARNESSES AND OTHER WIRING APPROX AS SHOWN TO PERMIT REAR PANEL TO LAY OPEN FOR WIRING
7 WIRE PER DANA WORKMANSHIP AND PROCEDURE STANDARDS
NOTE: UNLESS OTHERWISE SPECIFIED
8 LOCKWASHER NOT USED WITH GROUND LUG P/N 800032
9 CONNECTOR SHELLS ARE KEYED AS INDICATED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ENCLOSURE ASSY - MODEL 2802-2

| SIZE | CODE IDENT NO | DWG NO | REV |
|---|---|---|---|
| D | 21793 | 402948 | C |

SCALE | WT | SHEET 8 OF 12

PARTS LIST

ASSEMBLY 402310 – Model 2850, PC Board Assembly - Amp, 100 ma O.P. w/Variband, V1 Option

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CR01 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR02 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR03 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR04 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR05 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR06 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR07 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR08 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR09 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR10 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR11 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR12 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR13 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR14 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR15 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR16 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR17 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR18 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR19 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR20 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR21 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR22 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR23 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR24 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR25 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR26 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR27 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR28 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR29 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR30 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR31 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR32 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR33 | 220016 | DIODE | SILICO | ZENER | 1N964B | | MOTOROLA | 1N964B |
| CR34 | 220016 | DIODE | SILICO | ZENER | 1N964B | | MOTOROLA | 1N964B |
| CR35 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |

## PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CR36 | 220011 | DIODE | SILICO | ZENER | 1N968A | | MOTOROLA | 1N968A |
| CR37 | 220011 | DIODE | SILICO | ZENER | 1N968A | | MOTOROLA | 1N968A |
| CR38 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR39 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR40 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR41 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR42 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR43 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR44 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR45 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR46 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| C01 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C02 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C03 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C07 | 121093 | CAP | MYLAR | .047 MFD | 100 V | 10% | CDE | WMF1S47 |
| C08 | 121091 | CAP | MYLAR | .033 MFD | 100 V | 10% | CDE | WMF1S33 |
| C09 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |
| C10 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C11 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C12 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C13 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C14 | 101641 | CAP | CERAM | 470 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C15 | 130004 | CAP | CERAM | 2-8 PFD | 500 V | 10% | ERIE | 538-00289R |
| C17 | 100009 | CAP | CERAM | 5 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C18 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C19 | 111262 | CAP | ELECT | 10 MFD | 25 V | 20% | SPRAGUE | TE1204 |
| C20 | 121091 | CAP | MYLAR | .033 MFD | 100 V | 10% | CDE | WMF1S33 |
| C21 | 101641 | CAP | CERAM | 470 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C22 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C23 | 101098 | CAP | CERAM | 330 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C24 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C25 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |
| C26 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C27 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C28 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |

PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| C29 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |
| C30 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C31 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C32 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |
| C33 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |
| C34 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C35 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C36 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |
| C37 | 100013 | CAP | CERAM | 15 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C38 | 101175 | CAP | CERAM | 220 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C39 | 101642 | CAP | CERAM | 150 PFD | 500 V | 10% | AEROVOX | SCD2X5F |
| C40 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |
| C41 | 121473 | CAP | MYLAR | .0015 MFD | 100 V | 10% | CDE | WMF1S47 |
| C42 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C43 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C44 | 101175 | CAP | CERAM | 220 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C45 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C46 | 111095 | CAP | ELECT | 1 MFD | 25 V | 20% | SPRAGUE | TE1200 |
| C47 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C48 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C49 | 111095 | CAP | ELECT | 1 MFD | 25 V | 20% | SPRAGUE | TE1200 |
| C50 | 121468 | CAP | MYLAR | .022 MFD | 100 V | 10% | CDE | WMF1S22 |
| C51 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C52 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C53 | 110060 | CAP | ELECT | 50 MFD | 25 V | | SPRAGUE | TE1209 |
| C54 | 110060 | CAP | ELECT | 50 MFD | 25 V | | SPRAGUE | TE1209 |
| C55 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C56 | 110062 | CAP | ELECT | 500 MFD | 50 V | | SPRAGUE | 39D507G050L4 |
| C57 | 110062 | CAP | ELECT | 500 MFD | 50 V | | SPRAGUE | 39D507G050L4 |
| C58 | 110061 | CAP | ELECT | 100 MFD | 50 V | | SPRAGUE | 39D107G050EJ4 |
| C59 | 110061 | CAP | ELECT | 100 MFD | 50 V | | SPRAGUE | 39D107G050EJ4 |
| C60 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |
| C61 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C62 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C63 | 100017 | CAP | CERAM | .01 MFD | 200 V | 10% | SPRAGUE | TH-S10 |

D&N

## PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| C64 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C65 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C66 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| Q01 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q02 | 402718 | ASSY | FSV | | 401718 | | DANA | 402718 |
| Q03 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q04 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q05 | 201285 | TRANS | DUAL | NPN | 016S | | DANA | 201285 |
| Q06 | 200078 | TRANS | SILICO | NPN | FSV | | DANA | 200078 |
| Q07 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q08 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q09 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q10 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q11 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q12 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q13 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q14 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q15 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q16 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q17 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q18 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q19 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q20 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q21 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q22 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q23 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q24 | 200022 | TRANS | SILICO | PNP | 012 2N 4248 | | DANA | 200022 |
| Q25 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q26 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q27 | 200040 | TRANS | SILICO | NPN | 016 | | DANA | 200040 |
| Q28 | 200040 | TRANS | SILICO | NPN | 016 | | DANA | 200040 |
| Q29 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q30 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q31 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q32 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |

## PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q33 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q34 | 200043 | TRANS | SILICO | NPN | 2N3565 | | | FAIRCHILD | 2N3565 |
| Q35 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q36 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q37 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q38 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q39 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q40 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| R01 | 020106 | RES | WW | 100 OHM | | .3% | 1/8W | CF ELEC | CF-4012 |
| R02 | 000392 | RES | CARBON | 0003.9 K | | 5% | 1/4W | OHMITE | RC07GF392J |
| R04 | 020106 | RES | WW | 100 OHM | | .3% | 1/8W | CF ELEC | CF-4012 |
| R05 | 000392 | RES | CARBON | 0003.9 K | | 5% | 1/4W | OHMITE | RC07GF392J |
| R11 | 000621 | RES | CARBON | 620 OHM | | 5% | 1/4W | OHMITE | RC07GF621J |
| R12 | 000152 | RES | CARBON | 1.5 K | | 5% | 1/4W | OHMITE | RC07GF152J |
| R13 | 000242 | RES | CARBON | 2.4 K | | 5% | 1/4W | OHMITE | RC07GF242J |
| R14 | 000472 | RES | CARBON | 4.7 K | | 5% | 1/4W | OHMITE | RC07GF472J |
| R15 | 020424 | RES | WW | 9.179 K | | .05% | | JORDAN | J11 |
| R16 | 020423 | RES | WW | 3.442K | | .05% | | JORDAN | J11 |
| R17 | 020422 | RES | WW | 1.530 K | | .05% | | JORDAN | J11 |
| R18 | 020421 | RES | WW | 573.7 OHM | | .05% | | JORDAN | J11 |
| R19 | 020420 | RES | WW | 281 OHM | | .05% | | CF | M18 |
| R20 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |
| R21 | 020086 | RES | WW | 840 OHM | | .1% | 1/8W | KELVIN | EP-20 |
| R22 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |
| R23 | 020079 | RES | WW | 100 K | | .1% | 1/8W | JORDAN | J11 |
| R24 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |
| R25 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |
| R26 | 020079 | RES | WW | 100 K | | .1% | 1/8W | JORDAN | J11 |
| R27 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |
| R28 | 040092 | RES | VARI | 20 K | | | | SPECTRO | 50-3-1-203 |
| R29 | 040092 | RES | VARI | 20 K | | | | SPECTRO | 50-3-1-203 |
| R30 | 011178 | RES | METAL | 4.99 K | | 1% | 1/4W | ELECTRA | RN20X4994F |
| R31 | 011178 | RES | METAL | 4.99 K | | 1% | 1/4W | ELECTRA | RN20X4994F |
| R32 | 010130 | RES | METAL | 6.19 K | | 1% | 1/4W | ELECTRA | RN60D6191F |
| R33 | 402718 | ASSY | FSV | | 402718 | | | DANA | 402718 |

PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R34 | 010059 | RES | METAL | 20 K | | 1% 1/4W | ELECTRA | RN60D2002F |
| R35 | 010059 | RES | METAL | 20 K | | 1% 1/4W | ELECTRA | RN60D2002F |
| R36 | 010110 | RES | METAL | 10 K | | 1% 1/2W | ELECTRA | RN65C1002F |
| R37 | 040093 | RES | VARI | 500 OHM | | | SPECTRO | 50-3-1-501 |
| R38 | 402718 | ASSY | FSV | | 402718 | | DANA | 402718 |
| R39 | 402718 | ASSY | FSV | | 402718 | | DANA | 402718 |
| R40 | 020078 | RES | WW | 50 K | | .1% 1/8W | JORDAN | J11 |
| R41 | 020078 | RES | WW | 50 K | | .1% 1/8W | JORDAN | J11 |
| R42 | 020425 | RES | WW | 10.455 K | | .1% | CF | M20 |
| R43 | 040108 | RES | VARI | 50 OHM | | | SPECTROL | 50-3 |
| R44 | 020425 | RES | WW | 10.455 K | | .1% | CF | M20 |
| R45 | 402718 | ASSY | FSV | | 402718 | | DANA | 402718 |
| R46 | 040020 | RES | VARI | 1 K | | 10% 1/4W | BOURNS | 271-1-102-M |
| R47 | 402718 | ASSY | FSV | | 402718 | | DANA | 402718 |
| R48 | 402718 | ASSY | FSV | | 402718 | | DANA | 402718 |
| R49 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R50 | 020104 | RES | WW | 3.75 K | | 1% 1/8W | CF ELECT | CF3133 |
| R51 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R52 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R53 | 000512 | RES | CARBON | 5.1 K | | 5% 1/4W | OHMITE | RC07GF512J |
| R54 | 000153 | RES | CARBON | 15 K | | 5% 1/4W | OHMITE | RC07GF153J |
| R55 | 000752 | RES | CARBON | 7.5 K | | 5% 1/4W | OHMITE | RC07GF752J |
| R56 | 000123 | RES | CARBON | 12 K | | 5% 1/4W | OHMITE | RC07GF123J |
| R57 | 000393 | RES | CARBON | 39 K | | 5% 1/4W | OHMITE | RC07GF393J |
| R58 | 000393 | RES | CARBON | 39 K | | 5% 1/4W | OHMITE | RC07GF393J |
| R59 | 000104 | RES | CARBON | 100 K | | 5% 1/4W | OHMITE | RC07GF104J |
| R60 | 010019 | RES | METAL | 30.1 K | | 1% 1/4W | ELECTRA | RN60B3012F |
| R61 | 000153 | RES | CARBON | 15 K | | 5% 1/4W | OHMITE | RC07GF153J |
| R62 | 011334 | RES | METAL | 2.61 K | | 1% 1/4W | ELECTRA | RN60D2611F |
| R63 | 010008 | RES | METAL | 1.4 K | | 1% 1/4W | IRC | RN60D142F |
| R64 | 000103 | RES | CARBON | 10 K | | 5% 1/4W | OHMITE | RC07GF103J |
| R65 | 000103 | RES | CARBON | 10 K | | 5% 1/4W | OHMITE | RC07GF103J |
| R66 | 000221 | RES | CARBON | 220 OHM | | 5% 1/4W | OHMITE | RC07GF221J |
| R67 | 010027 | RES | METAL | 499 OHM | | 1% 1/4W | ELECTRA | RN60D4990F |
| R68 | 000123 | RES | CARBON | 12 K | | 5% 1/4W | OHMITE | RC07GF123J |

PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | |
|---|---|---|---|---|---|---|---|
| R69 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R70 | 000204 | RES | CARBON | 200 K | 5% 1/4W | OHMITE | RC07GF204J |
| R71 | 000221 | RES | CARBON | 220 OHM | 5% 1/4W | OHMITE | RC07GF221J |
| R72 | 000823 | RES | CARBON | 82 K | 5% 1/4W | OHMITE | RC07GF823J |
| R73 | 000222 | RES | CARBON | 2.2 K | 5% 1/4W | OHMITE | RC07GF222J |
| R74 | 000153 | RES | CARBON | 15 K | 5% 1/4W | OHMITE | RC07GF153J |
| R75 | 000152 | RES | CARBON | 1.5 K | 5% 1/4W | OHMITE | RC07GF152J |
| R76 | 020119 | RES | WW | 680 OHM | 1% 1/2W | CF ELECT | M20 |
| R77 | 000822 | RES | CARBON | 8.2 K | 5% 1/4W | OHMITE | RC07GF822J |
| R78 | 000223 | RES | CARBON | 22 K | 5% 1/4W | OHMITE | RC07GF223J |
| R79 | 000472 | RES | CARBON | 4.7 K | 5% 1/4W | OHMITE | RC07GF472J |
| R80 | 000393 | RES | CARBON | 39 K | 5% 1/4W | OHMITE | RC07GF393J |
| R81 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R82 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R83 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R84 | 000393 | RES | CARBON | 39 K | 5% 1/4W | OHMITE | RC07GF393J |
| R85 | 000122 | RES | CARBON | 1.2 K | 5% 1/4W | OHMITE | RC07GF122J |
| R86 | 000510 | RES | CARBON | 51 OHM | 5% 1/4W | OHMITE | RC07GF510J |
| R87 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R88 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R89 | 001159 | RES | CARBON | 330 OHM | 5% 1/2W | OHMITE | RC20GF331J |
| R90 | 001159 | RES | CARBON | 330 OHM | 5% 1/2W | OHMITE | RC20GF331J |
| R91 | 000273 | RES | CARBON | 27 K | 5% 1/4W | OHMITE | RC07GF273J |
| R92 | 000122 | RES | CARBON | 1.2 K | 5% 1/4W | OHMITE | RC07GF122J |
| R93 | 000510 | RES | CARBON | 51 OHM | 5% 1/4W | OHMITE | RC07GF510J |
| R94 | 000124 | RES | CARBON | 120 K | 5% 1/4W | OHMITE | RC07GF124J |
| R95 | 010086 | RES | METAL | 9.53 K | 1% 1/4W | ELECTRA | RN60D9531F |
| R96 | 010020 | RES | METAL | 4.99 K | 1% 1/4W | ELECTRA | RN60D4991F |
| R97 | 010324 | RES | METAL | 10.7 K | 1% | CORNING | RN60D1072F |
| R98 | 010211 | RES | METAL | 4.42 K | 1% | CORNING | RN60D |
| R99 | 000622 | RES | CARBON | 6.2 K | 5% 1/4W | OHMITE | RC07GF622J |
| R100 | 000104 | RES | CARBON | 100 K | 5% 1/4W | OHMITE | RC07GF104J |
| R101 | 000302 | RES | CARBON | 3 K | 5% 1/4W | OHMITE | RC07GF302J |
| R102 | 000301 | RES | CARBON | 300 OHM | 5% 1/4W | OHMITE | RC07GF301J |
| R103 | 000162 | RES | CARBON | 1.6 K | 5% 1/4W | OHMITE | RC07GF162J |

PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R104 | 000183 | RES | CARBON | 18 K | 5% 1/4W | OHMITE | RC07GF183J |
| R105 | 000151 | RES | CARBON | 150 OHM | 5% 1/4W | OHMITE | RC07GF151J |
| R106 | 000202 | RES | CARBON | 2 K | 5% 1/4W | OHMITE | RC07GF202J |
| R107 | 000752 | RES | CARBON | 7.5 K | 5% 1/4W | OHMITE | RC07GF752J |
| R108 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R109 | 010082 | RES | METAL | 9.31 K | 1% 1/4W | ELECTRA | RN60D9311F |
| R110 | 040109 | RES | VARI | 5 K | | SPECTROL | 50-3 |
| R111 | 010082 | RES | METAL | 9.31 K | 1% 1/4W | ELECTRA | RN60D9311F |
| R112 | 000202 | RES | CARBON | 2 K | 5% 1/4W | OHMITE | RC07GF202J |
| R113 | 010088 | RES | METAL | 8.45 K | 1% 1/4W | ELECTRA | RN60D8451F |
| R114 | 011332 | RES | METAL | 1 K | 1% 1/4W | ELECTRA | RN60D1001F |
| R115 | 010084 | RES | METAL | 54.9 K | 1% 1/4W | ELECTRA | RN60D5492F |
| R116 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R117 | 011332 | RES | METAL | 1 K | 1% 1/4W | ELECTRA | RN60D1001F |
| R118 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R119 | 010113 | RES | METAL | 15 K | 1% 1/4W | ELECTRA | RN60D1502F |
| R120 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R121 | 010020 | RES | METAL | 4.99 K | 1% 1/4W | ELECTRA | RN60D4991F |
| R122 | 010086 | RES | METAL | 9.53 K | 1% 1/4W | ELECTRA | RN60D9531F |
| R123 | 010087 | RES | METAL | 11.5 K | 1% 1/4W | ELECTRA | RN60D1152F |
| R124 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R125 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R126 | 010137 | RES | METAL | 100 OHM | 1% 1/4W | ELECTRA | RN60D1000F |
| R127 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R128 | 000471 | RES | CARBON | 470 OHM | 5% 1/4W | OHMITE | RC07GF471J |
| R129 | 000301 | RES | CARBON | 300 OHM | 5% 1/4W | OHMITE | RC07GF301J |
| R130 | 040022 | RES | VARI | 500 OHM | 10% 1.5 W | CTS | 110 |
| R131 | 000681 | RES | CARBON | 680 OHM | 5% 1/4W | OHMITE | RC07GF681J |
| R132 | 000681 | RES | CARBON | 680 OHM | 5% 1/4W | OHMITE | RC07GF681J |
| R133 | 040022 | RES | VARI | 500 OHM | 10% 1.5 W | CTS | 110 |
| R134 | 001699 | RES | CARBON | 20 OHM | 5% 1/2W | OHMITE | RC20GF200J |
| R135 | 001699 | RES | CARBON | 20 OHM | 5% 1/2W | OHMITE | RC20GF200J |
| R136 | 001699 | RES | CARBON | 20 OHM | 5% 1/2W | OHMITE | RC20GF200J |
| R137 | 001699 | RES | CARBON | 20 OHM | 5% 1/2W | OHMITE | RC20GF200J |
| R138 | 000100 | RES | CARBON | 10 OHM | 5% 1/4W | OHMITE | RC07GF100J |

## PARTS LIST

ASSEMBLY 402310 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | |
|---|---|---|---|---|---|---|---|
| R139 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R140 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R141 | 000302 | RES | CARBON | 3 K | 5% 1/4W | OHMITE | RC07GF302J |
| R142 | 000100 | RES | CARBON | 10 OHM | 5% 1/4W | OHMITE | RC07GF100J |
| R143 | 001682 | RES | CARBON | 1.5 K | 5% 1/2W | OHMITE | RC20GF152J |
| R144 | 000100 | RES | CARBON | 10 OHM | 5% 1/4W | OHMITE | RC07GF100J |
| R145 | 001682 | RES | CARBON | 1.5 K | 5% 1/2W | OHMITE | RC20GF152J |
| R146 | 030003 | RES | WW | 39 OHM | 1/8W | JORDAN | J11 |
| R147 | 000151 | RES | CARBON | 150 OHM | 5% 1/4W | OHMITE | RC07GF151J |
| R148 | 020106 | RES | WW | 100 OHM | .3% 1/8W | CF ELECT | CF-4012 |
| R149 | 020106 | RES | WW | 100 OHM | .3% 1/8W | CF ELECT | CF-4012 |
| R150 | 000101 | RES | CARBON | 100 OHM | 5% 1/4W | OHMITE | RC07GF101J |

PARTS LIST

ASSEMBLY 402311 -- Model 2850, PC Board Assembly - Amp, 100 mA O.P. w/Variband V2 Option

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CR01 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR02 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR03 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR04 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR05 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR06 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR07 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR08 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR09 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR10 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR11 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR12 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR13 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR14 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR15 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR16 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR17 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR18 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR19 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR20 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR21 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR22 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR23 | 211083 | DIODE | SILICO | | 018 | | DANA | 211083 |
| CR24 | 221177 | DIODE | SILICO | ZENER | | 1/4W | MOTOROLA | M2.4AZ5 |
| CR25 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR26 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR27 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR28 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR29 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR30 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR31 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR32 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR33 | 220016 | DIODE | SILICO | ZENER | 1N964B | | MOTOROLA | 1N964B |
| CR34 | 220016 | DIODE | SILICO | ZENER | 1N964B | | MOTOROLA | 1N964B |
| CR35 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |

PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CR36 | 220011 | DIODE | SILICO | ZENER | 1N968A | | MOTOROLA | 1N968A |
| CR37 | 220011 | DIODE | SILICO | ZENER | 1N968A | | MOTOROLA | 1N968A |
| CR38 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR39 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR40 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR41 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR42 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR43 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR44 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR45 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| CR46 | 210004 | DIODE | SILICO | | SD4 | | DIODES, INC. | SD4 |
| C01 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C02 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C03 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C04 | 100006 | CAP | CERAM | 10 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C05 | 130004 | CAP | CERAM | 2-8 PFD | 500 V | 10% | ERIE | 538-00289R |
| C06 | 101641 | CAP | CERAM | 470 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C07 | 121093 | CAP | MYLAR | .047 MFD | 100 V | 10% | CDE | WMF1S47 |
| C08 | 121091 | CAP | MYLAR | .033 MFD | 100 V | 10% | CDE | WMF1S33 |
| C09 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |
| C10 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C11 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C12 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C13 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C14 | 101641 | CAP | CERAM | 470 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C15 | 130004 | CAP | CERAM | 2-8 PFD | 500 V | 10% | ERIE | 538-00289R |
| C17 | 100009 | CAP | CERAM | 5 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C18 | 121088 | CAP | MYLAR | .01 MFD | 100 V | 10% | CDE | WMF1S1 |
| C19 | 111262 | CAP | ELECT | 10 MFD | 25 V | 20% | SPRAGUE | TE1204 |
| C20 | 121091 | CAP | MYLAR | .033 MFD | 100 V | 10% | CDE | WMF1S33 |
| C21 | 101641 | CAP | CERAM | 470 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C22 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C23 | 101098 | CAP | CERAM | 330 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C24 | 121092 | CAP | MYLAR | .0022 MFD | 100 V | 10% | CDE | WMF1D22 |
| C25 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |

PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| C26 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C27 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C28 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |
| C29 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |
| C30 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C31 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C32 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |
| C33 | 120129 | CAP | MYLAR | 1.5 MFD | 100 V | 5% | IMB | XT2B155J |
| C34 | 120130 | CAP | MYLAR | .15 MFD | 100 V | 5% | IMB | XT2B154J |
| C35 | 120131 | CAP | MYLAR | .015 MFD | 100 V | 5% | IMB | XT2B153J |
| C36 | 120132 | CAP | MYLAR | .0013 MFD | 100 V | 5% | IMB | XT2B132J |
| C37 | 100013 | CAP | CERAM | 15 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C38 | 101175 | CAP | CERAM | 220 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C39 | 101642 | CAP | CERAM | 150 PFD | 500 V | 10% | AEROVOX | SCD2X5F |
| C40 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |
| C41 | 121473 | CAP | MYLAR | .0015 MFD | 100 V | 10% | CDE | WMF1S47 |
| C42 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C43 | 101145 | CAP | CERAM | 100 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C44 | 101175 | CAP | CERAM | 220 PFD | 500 V | 10% | AEROVOX | SCD1X5F |
| C45 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C46 | 111095 | CAP | ELECT | 1 MFD | 25 V | 20% | SPRAGUE | TE1200 |
| C47 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C48 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C49 | 111095 | CAP | ELECT | 1 MFD | 25 V | 20% | SPRAGUE | TE1200 |
| C50 | 121468 | CAP | MYLAR | .022 MFD | 100 V | 10% | CDE | WMF1S22 |
| C51 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C52 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C53 | 110060 | CAP | ELECT | 50 MFD | 25 V | | SPRAGUE | TE1209 |
| C54 | 110060 | CAP | ELECT | 50 MFD | 25 V | | SPRAGUE | TE1209 |
| C55 | 101182 | CAP | CERAM | 47 PFD | 500 V | 10% | AEROVOX | TCD-N750 |
| C56 | 110062 | CAP | ELECT | 500 MFD | 50 V | | SPRAGUE | 39D507G050L4 |
| C57 | 110062 | CAP | ELECT | 500 MFD | 50 V | | SPRAGUE | 39D507G050L4 |
| C58 | 110061 | CAP | ELECT | 100 MFD | 50 V | | SPRAGUE | 39D107G050EJ4 |
| C59 | 110061 | CAP | ELECT | 100 MFD | 50 V | | SPRAGUE | 39D107G050EJ4 |
| C60 | 121090 | CAP | MYLAR | .015 MFD | 100 V | 10% | CDE | WMF1S15 |

PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| C61 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C62 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C63 | 100017 | CAP | CERAM | .01 MFD | 200 V | 10% | SPRAGUE | TH-S10 |
| C64 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C65 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| C66 | 101174 | CAP | CERAM | .001 MFD | 500 V | 10% | AEROVOX | SCD3X5F |
| Q01 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q02 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| Q03 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q04 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q05 | 201285 | TRANS | DUAL | NPN | 016S | | DANA | 201285 |
| Q06 | 200078 | TRANS | SILICO | NPN | FSV | | DANA | 200078 |
| Q07 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q08 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q09 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q10 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q11 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q12 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q13 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q14 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q15 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q16 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q17 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q18 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q19 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q20 | 200011 | TRANS | SILICO | PNP | 009 | | DANA | 200011 |
| Q21 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |
| Q22 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q23 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q24 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q25 | 200022 | TRANS | SILICO | PNP | 012 | | DANA | 200022 |
| Q26 | 200043 | TRANS | SILICO | NPN | 2N3565 | | FAIRCHILD | 2N3565 |
| Q27 | 200040 | TRANS | SILICO | NPN | 016 | | DANA | 200040 |
| Q28 | 200040 | TRANS | SILICO | NPN | 016 | | DANA | 200040 |
| Q29 | 200035 | TRANS | SILICO | NPN | 014 | | DANA | 200035 |

## PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q30 | 200043 | TRANS | SILICO | NPN | 2N3565 | | | FAIRCHILD | 2N3565 |
| Q31 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q32 | 200043 | TRANS | SILICO | NPN | 2N3565 | | | FAIRCHILD | 2N3565 |
| Q33 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q34 | 200043 | TRANS | SILICO | NPN | 2N3565 | | | FAIRCHILD | 2N3565 |
| Q35 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q36 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q37 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q38 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| Q39 | 200035 | TRANS | SILICO | NPN | 014 | | | DANA | 200035 |
| Q40 | 200011 | TRANS | SILICO | PNP | 009 | | | DANA | 200011 |
| R01 | 020106 | RES | WW | 100 OHM | | .3% | 1/8W | CF ELECT | CF-4012 |
| R02 | 000392 | RES | CARBON | 0003.9 K | | 5% | 1/4W | OHMITE | RC07GF392J |
| R03 | 010111 | RES | METAL | 1 MEG | | 1% | | CORNING | RN65C1004F |
| R04 | 020106 | RES | WW | 100 OHM | | .3% | 1/8W | CF ELECT | CF-4012 |
| R05 | 000392 | RES | CARBON | 0003.9 K | | 5% | 1/4W | OHMITE | RC07GF392J |
| R06 | 010111 | RES | METAL | 1 MEG | | 1% | | CORNING | RN65C1004F |
| R07 | 402719 | ASSY | FSV | | 402719 | | | DANA | 402719 |
| R08 | 020097 | RES | WW | 10 K | | .1% | 1/8W | JORDAN | J11 |
| R09 | 020097 | RES | WW | 10 K | | .1% | 1/8W | JORDAN | J11 |
| R10 | 040093 | RES | VARI | 500 OHM | | | | SPECTROL | 50-3-1-501 |
| R11 | 000621 | RES | CARBON | 620 OHM | | 5% | 1/4W | OHMITE | RC07GF621J |
| R12 | 000152 | RES | CARBON | 1.5 K | | 5% | 1/4W | OHMITE | RC07GF152J |
| R13 | 000242 | RES | CARBON | 2.4 K | | 5% | 1/4W | OHMITE | RC07GF242J |
| R14 | 000472 | RES | CARBON | 4.7 K | | 5% | 1/4W | OHMITE | RC07GF472J |
| R15 | 020424 | RES | WW | 9.179 K | | .05% | | JORDAN | J11 |
| R16 | 020423 | RES | WW | 3.442 K | | .05% | | JORDAN | J11 |
| R17 | 020422 | RES | WW | 1.530 K | | .05% | | JORDAN | J11 |
| R18 | 020421 | RES | WW | 573.7 OHM | | .05% | | JORDAN | J11 |
| R19 | 020420 | RES | WW | 281 OHM | | .05% | | CF | M18 |
| R20 | 402719 | ASSY | FSV | | 402719 | | | DANA | 402719 |
| R21 | 020086 | RES | WW | 840 OHM | | .1% | 1/8W | KELVIN | EP-20 |
| R22 | 402719 | ASSY | FSV | | 402719 | | | DANA | 402719 |
| R23 | 020079 | RES | WW | 100 K | | .1% | 1/8W | JORDAN | J11 |
| R24 | 402719 | ASSY | FSV | | 402719 | | | DANA | 402719 |

PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R25 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R26 | 020079 | RES | WW | 100 K | | .1% 1/8W | JORDAN | J11 |
| R27 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R28 | 040092 | RES | VARI | 20 K | | | SPECTROL | 50-3-1-203 |
| R29 | 040092 | RES | VARI | 20 K | | | SPECTROL | 50-3-1-203 |
| R30 | 011178 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN20X4994F |
| R31 | 011178 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN20X4994F |
| R32 | 010130 | RES | METAL | 6.19 K | | 1% 1/4W | ELECTRA | RN60D6191F |
| R33 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R34 | 010059 | RES | METAL | 20 K | | 1% 1/4W | ELECTRA | RN60D2002F |
| R35 | 010059 | RES | METAL | 20 K | | 1% 1/4W | ELECTRA | RN60D2002F |
| R36 | 010110 | RES | METAL | 10 K | | 1% 1/2W | ELECTRA | RN65C1002F |
| R37 | 040093 | RES | VARI | 500 OHM | | | SPECTROL | 50-3-1-501 |
| R38 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R39 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R40 | 020078 | RES | WW | 50 K | | .1% 1/8W | JORDAN | J11 |
| R41 | 020078 | RES | WW | 50 K | | .1% 1/8W | JORDAN | J11 |
| R42 | 020425 | RES | WW | 10.455 K | | .1% | CF | M20 |
| R43 | 040108 | RES | VARI | 50 OHM | | | SPECTROL | 50-3 |
| R44 | 020425 | RES | WW | 10.455 K | | .1% | CF | M20 |
| R45 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R46 | 040020 | RES | VARI | 1 K | | 10% 1/4W | BOURNS | 271-1-102-M |
| R47 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R48 | 402719 | ASSY | FSV | | 402719 | | DANA | 402719 |
| R49 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R50 | 020104 | RES | WW | 3.75 K | | 1% 1/8W | CF ELECT | CF3133 |
| R51 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R52 | 010020 | RES | METAL | 4.99 K | | 1% 1/4W | ELECTRA | RN60D4991F |
| R53 | 000512 | RES | CARBON | 5.1 K | | 5% 1/4W | OHMITE | RC07GF512J |
| R54 | 000153 | RES | CARBON | 15 K | | 5% 1/4W | OHMITE | RC07GF153J |
| R55 | 000752 | RES | CARBON | 7.5 K | | 5% 1/4W | OHMITE | RC07GF752J |
| R56 | 000123 | RES | CARBON | 12 K | | 5% 1/4W | OHMITE | RC07GF123J |
| R57 | 000393 | RES | CARBON | 39 K | | 5% 1/4W | OHMITE | RC07GF393J |
| R58 | 000393 | RES | CARBON | 39 K | | 5% 1/4W | OHMITE | RC07GF393J |
| R59 | 000104 | RES | CARBON | 100 K | | 5% 1/4W | OHMITE | RC07GF104J |

PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | |
|---|---|---|---|---|---|---|---|
| R60 | 010019 | RES | METAL | 30.1 K | 1% 1/4W | ELECTRA | RN60B3012F |
| R61 | 000153 | RES | CARBON | 15 K | 5% 1/4W | OHMITE | RC07GF153J |
| R62 | 011334 | RES | METAL | 2.61 K | 1% 1/4W | ELECTRA | RN60D2611F |
| R63 | 010008 | RES | METAL | 1.4 K | 1% 1/4W | IRC | RN60D142F |
| R64 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R65 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R66 | 000221 | RES | CARBON | 220 OHM | 5% 1/4W | OHMITE | RC07GF221J |
| R67 | 010027 | RES | METAL | 499 OHM | 1% 1/4W | ELECTRA | RN60D4990F |
| R68 | 000123 | RES | CARBON | 12 K | 5% 1/4W | OHMITE | RC07GF123J |
| R69 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R70 | 000204 | RES | CARBON | 200 K | 5% 1/4W | OHMITE | RC07GF204J |
| R71 | 000221 | RES | CARBON | 220 OHM | 5% 1/4W | OHMITE | RC07GF221J |
| R72 | 000823 | RES | CARBON | 82 K | 5% 1/4W | OHMITE | RC07GF823J |
| R73 | 000222 | RES | CARBON | 2.2 K | 5% 1/4W | OHMITE | RC07GF222J |
| R74 | 000153 | RES | CARBON | 15 K | 5% 1/4W | OHMITE | RC07GF153J |
| R75 | 000152 | RES | CARBON | 1.5 K | 5% 1/4W | OHMITE | RC07GF152J |
| R76 | 020119 | RES | WW | 680 OHM | 1% 1/2W | CF ELECT | M20 |
| R77 | 000822 | RES | CARBON | 8.2 K | 5% 1/4W | OHMITE | RC07GF822J |
| R78 | 000223 | RES | CARBON | 22 K | 5% 1/4W | OHMITE | RC07GF223J |
| R79 | 000472 | RES | CARBON | 4.7 K | 5% 1/4W | OHMITE | RC07GF472J |
| R80 | 000393 | RES | CARBON | 39 K | 5% 1/4W | OHMITE | RC07GF393J |
| R81 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R82 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R83 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R84 | 000393 | RES | CARBON | 39 K | 5% 1/4W | OHMITE | RC07GF393J |
| R85 | 000122 | RES | CARBON | 1.2 K | 5% 1/4W | OHMITE | RC07GF122J |
| R86 | 000510 | RES | CARBON | 51 OHM | 5% 1/4W | OHMITE | RC07GF510J |
| R87 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R88 | 000201 | RES | CARBON | 200 OHM | 5% 1/4W | OHMITE | RC07GF201J |
| R89 | 001159 | RES | CARBON | 330 OHM | 5% 1/2W | OHMITE | RC20GF331J |
| R90 | 001159 | RES | CARBON | 330 OHM | 5% 1/2W | OHMITE | RC20GF331J |
| R91 | 000273 | RES | CARBON | 27 K | 5% 1/4W | OHMITE | RC07GF273J |
| R92 | 000122 | RES | CARBON | 1.2 K | 5% 1/4W | OHMITE | RC07GF122J |
| R93 | 000510 | RES | CARBON | 51 OHM | 5% 1/4W | OHMITE | RC07GF510J |
| R94 | 000124 | RES | CARBON | 120 K | 5% 1/4W | OHMITE | RC07GF124J |

## PARTS LIST

ASSEMBLY 402311 – Model 2850

| REF DES | PART NO. | DESCRIPTION | | | | | |
|---|---|---|---|---|---|---|---|
| R95 | 010086 | RES | METAL | 9.53 K | 1% 1/4W | ELECTRA | RN60D9531F |
| R96 | 010020 | RES | METAL | 4.99 K | 1% 1/4W | ELECTRA | RN60D4991F |
| R97 | 010324 | RES | METAL | 10.7 K | 1% | CORNING | RN60D1072F |
| R98 | 010211 | RES | METAL | 4.42 K | 1% | CORNING | RN60D |
| R99 | 000622 | RES | CARBON | 6.2 K | 5% 1/4W | OHMITE | RC07GF622J |
| R100 | 000104 | RES | CARBON | 100 K | 5% 1/4W | OHMITE | RC07GF104J |
| R101 | 000302 | RES | CARBON | 3 K | 5% 1/4W | OHMITE | RC07GF302J |
| R102 | 000301 | RES | CARBON | 300 OHM | 5% 1/4W | OHMITE | RC07GF301J |
| R103 | 000162 | RES | CARBON | 1.6 K | 5% 1/4W | OHMITE | RC07GF162J |
| R104 | 000183 | RES | CARBON | 18 K | 5% 1/4W | OHMITE | RC07GF183J |
| R105 | 000151 | RES | CARBON | 150 OHM | 5% 1/4W | OHMITE | RC07GF151J |
| R106 | 000202 | RES | CARBON | 2 K | 5% 1/4W | OHMITE | RC07GF202J |
| R107 | 000752 | RES | CARBON | 7.5 K | 5% 1/4W | OHMITE | RC07GF752J |
| R108 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R109 | 010082 | RES | METAL | 9.31 K | 1% 1/4W | ELECTRA | RN60D9311F |
| R110 | 040109 | RES | VARI | 5 K | | SPECTROL | 50-3 |
| R111 | 010082 | RES | METAL | 9.31 K | 1% 1/4W | ELECTRA | RN60D9311F |
| R112 | 000202 | RES | CARBON | 2 K | 5% 1/4W | OHMITE | RC07GF202J |
| R113 | 010088 | RES | METAL | 8.45 K | 1% 1/4W | ELECTRA | RN60D8451F |
| R114 | 011332 | RES | METAL | 1 K | 1% 1/4W | ELECTRA | RN60D1001F |
| R115 | 010084 | RES | METAL | 54.9 K | 1% 1/4W | ELECTRA | RN60D5492F |
| R116 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R117 | 011332 | RES | METAL | 1 K | 1% 1/4W | ELECTRA | RN60D1001F |
| R118 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R119 | 010113 | RES | METAL | 15 K | 1% 1/4W | ELECTRA | RN60D1502F |
| R120 | 000103 | RES | CARBON | 10 K | 5% 1/4W | OHMITE | RC07GF103J |
| R121 | 010020 | RES | METAL | 4.99 K | 1% 1/4W | ELECTRA | RN60D4991F |
| R122 | 010086 | RES | METAL | 9.53 K | 1% 1/4W | ELECTRA | RN60D9531F |
| R123 | 010087 | RES | METAL | 11.5 K | 1% 1/4W | ELECTRA | RN60D1152F |
| R124 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R125 | 000392 | RES | CARBON | 0003.9 K | 5% 1/4W | OHMITE | RC07GF392J |
| R126 | 010137 | RES | METAL | 100 OHM | 1% 1/4W | ELECTRA | RN60D1000F |
| R127 | 000102 | RES | CARBON | 1 K | 5% 1/4W | OHMITE | RC07GF102J |
| R128 | 000471 | RES | CARBON | 470 OHM | 5% 1/4W | OHMITE | RC07GF471J |
| R129 | 000301 | RES | CARBON | 300 OHM | 5% 1/4W | OHMITE | RC07GF301J |

PARTS LIST

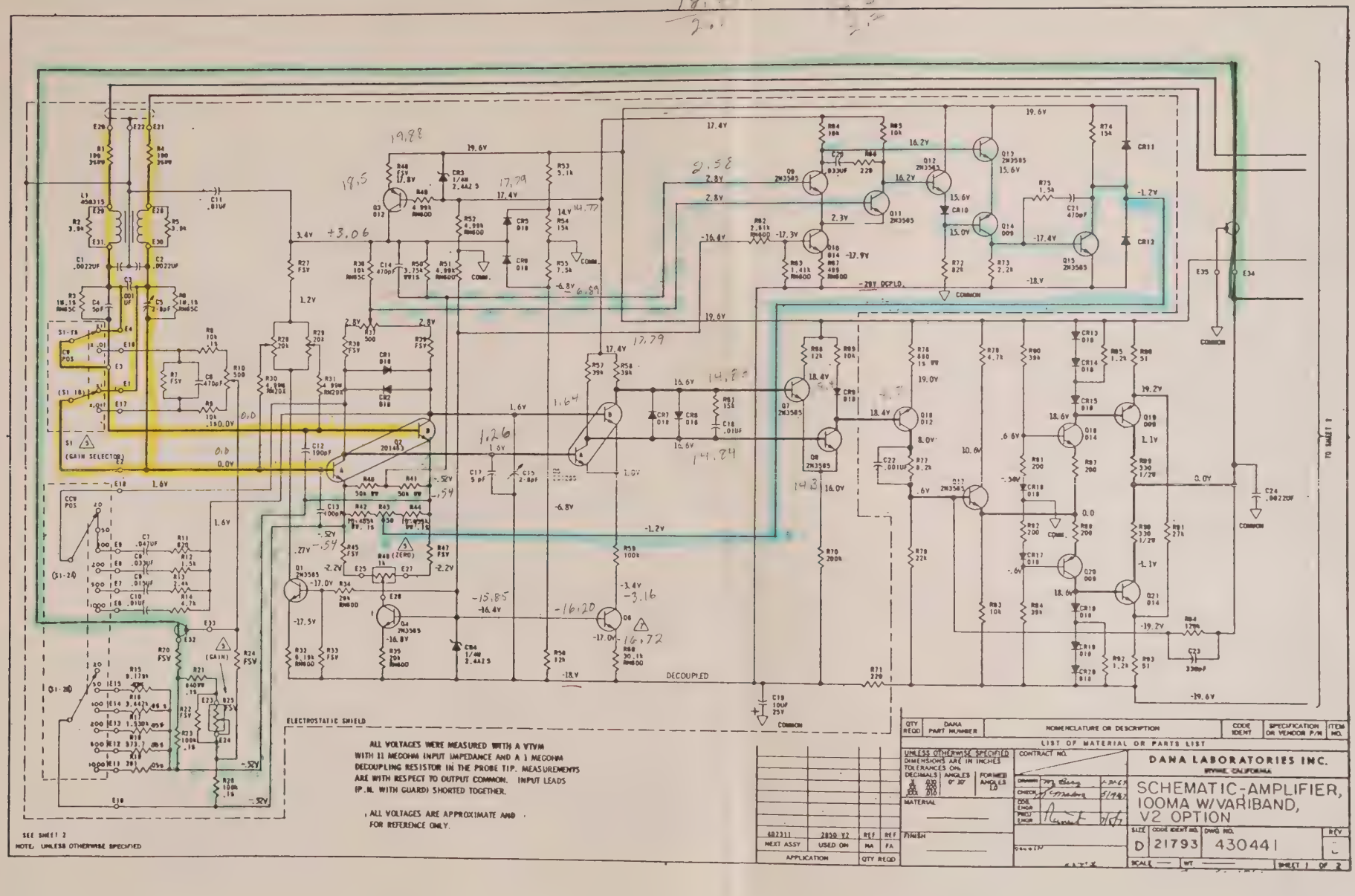
ASSEMBLY 402311 – Model 2850

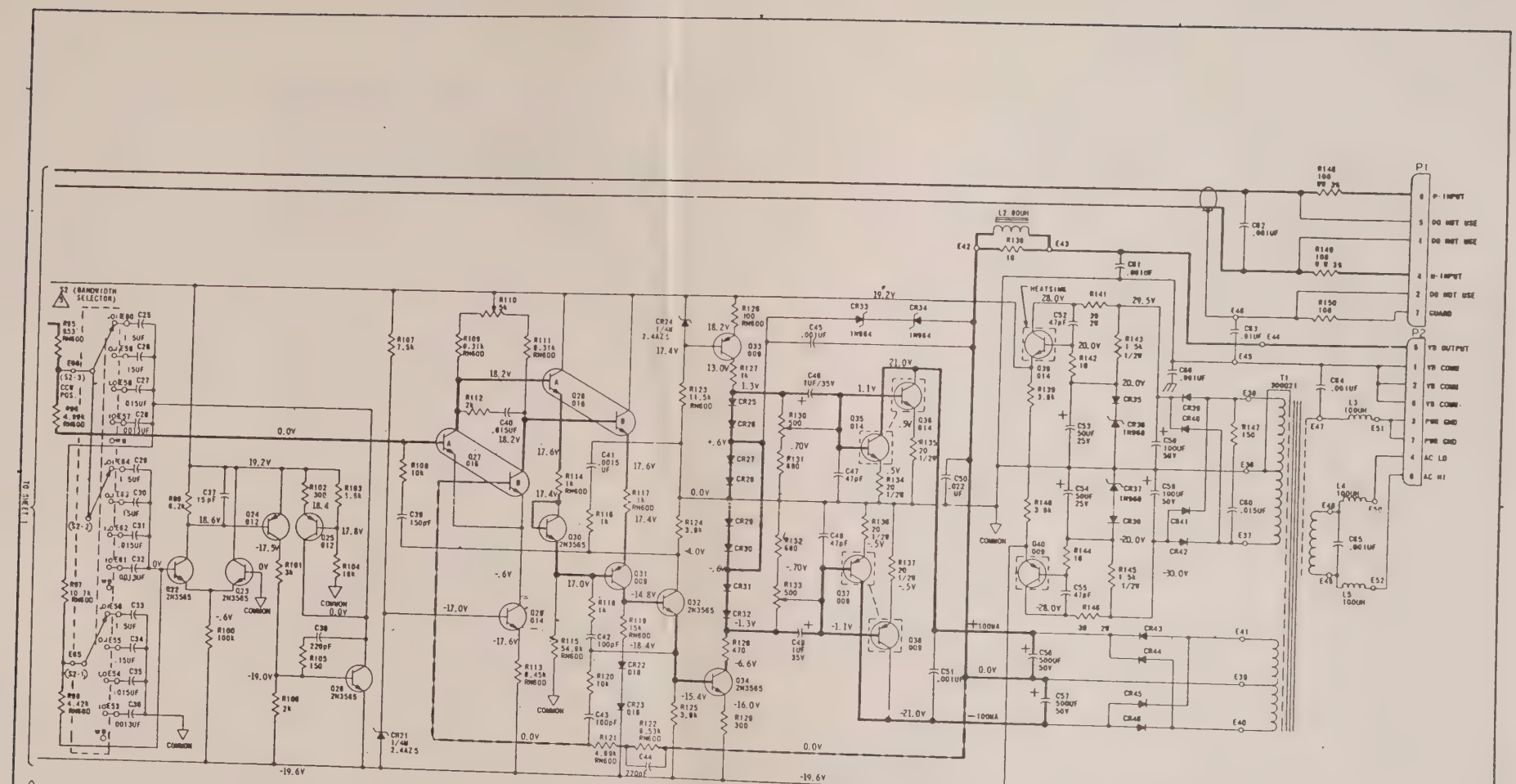
| REF DES | PART NO. | DESCRIPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R130 | 040022 | RES | VARI | 500 OHM | 10% | 1.5 W | CTS | 110 |
| R131 | 000681 | RES | CARBON | 680 OHM | 5% | 1/4W | OHMITE | RC07GF681J |
| R132 | 000681 | RES | CARBON | 680 OHM | 5% | 1/4W | OHMITE | RC07GF681J |
| R133 | 040022 | RES | VARI | 500 OHM | 10% | 1.5 W | CTS | 110 |
| R134 | 001699 | RES | CARBON | 20 OHM | 5% | 1/2W | OHMITE | RC20GF200J |
| R135 | 001699 | RES | CARBON | 20 OHM | 5% | 1/2W | OHMITE | RC20GF200J |
| R136 | 001699 | RES | CARBON | 20 OHM | 5% | 1/2W | OHMITE | RC20GF200J |
| R137 | 001699 | RES | CARBON | 20 OHM | 5% | 1/2W | OHMITE | RC20GF200J |
| R138 | 000100 | RES | CARBON | 10 OHM | 5% | 1/4W | OHMITE | RC07GF100J |
| R139 | 000392 | RES | CARBON | 0003.9 K | 5% | 1/4W | OHMITE | RC07GF392J |
| R140 | 000392 | RES | CARBON | 0003.9 K | 5% | 1/4W | OHMITE | RC07GF392J |
| R141 | 030003 | RES | WW | 39 OHM | | 1/8W | JORDAN | J11 |
| R142 | 000100 | RES | CARBON | 10 OHM | 5% | 1/4W | OHMITE | RC07GF100J |
| R143 | 001682 | RES | CARBON | 1.5 K | 5% | 1/2W | OHMITE | RC20GF152J |
| R144 | 000100 | RES | CARBON | 10 OHM | 5% | 1/4W | OHMITE | RC07GF100J |
| R145 | 001682 | RES | CARBON | 1.5 K | 5% | 1/2W | OHMITE | RC20GF152J |
| R146 | 030003 | RES | WW | 39 OHM | | 1/8W | JORDAN | J11 |
| R147 | 000151 | RES | CARBON | 150 OHM | 5% | 1/4W | OHMITE | RC07GF151J |
| R148 | 020106 | RES | WW | 100 OHM | .3% | 1/8W | CF ELECT | CF-4012 |
| R149 | 020106 | RES | WW | 100 OHM | .3% | 1/8W | CF ELECT | CF-4012 |
| R150 | 000101 | RES | CARBON | 100 OHM | 5% | 1/4W | OHMITE | RC07GF101J |

PARTS LIST

ASSEMBLY 402392 -- Model 2850, PC Board Assy - Amp, 100 ma O.P. w/Variband, V3 Option

| REF DES | PART NO. | DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| R10 | 020369 | RES | | 55.3 OHM | | 1% | | | |
| R11 | 000102 | RES | CARBON | 1 K | | 5% | 1/4W | OHMITE | RC07GF102J |
| R15 | 020423 | RES | WW | 3.442 K | | .05% | | JORDAN | J11 |
| R16 | 020422 | RES | WW | 1.530 K | | .05% | | JORDAN | J11 |
| R17 | 020421 | RES | WW | 573.7 OHM | | .05% | | JORDAN | J11 |
| R18 | 020420 | RES | WW | 281 OHM | | .05% | | CF | M18 |
| R19 | 020367 | RES | WW | 90 K | | 1% | 6 W | JORDAN | M51 |
| R20 | 402156 | ASSY | FSV | | 402156 | | | DANA | 402156 |
| R22 | 402156 | ASSY | FSV | | 402156 | | | DANA | 402156 |
| R24 | 402156 | ASSY | FSV | | 402156 | | | DANA | 402156 |
| R25 | 402156 | ASSY | FSV | | 402156 | | | DANA | 402156 |
| R46 | 040020 | RES | VARI | 1 K | | 10% | 1/4W | BOURNS | 271-1-102-M |


ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. WITH GUARD) SHORTED TOGETHER.
ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.
ELECTROSTATIC SHIELD
DECOUPLED
COMMON
(GAIN SELECTOR)
(GAIN)
SEE SHEET 2
NOTE: UNLESS OTHERWISE SPECIFIED
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC-AMPLIFIER, 100MA W/VARIBAND, V2 OPTION
D 21793 430441
LIST OF MATERIAL OR PARTS LIST
QTY REQD
DANA PART NUMBER
NOMENCLATURE OR DESCRIPTION
CODE IDENT
SPECIFICATION OR VENDOR P/N
ITEM NO.
CONTRACT NO.
SIZE
CODE IDENT NO.
DWG NO.
REV
SCALE
WT
SHEET 1 OF 2




⚠ TRANSISTOR Q7 IS A SELECTED 014 TRANSISTOR. (P/N 200078)

8. "E" NUMBERS DENOTE EYELETS AND CORRESPOND TO POINTS ON PC BRD. SEE ASSY DWGS #402312 (BASIC BRD ASSY) AND 402311 (BRD ASSY W/OPTION ADDED).

⚠ R25(GAIN), R46(ZERO), S1(GAIN SELECTOR) AND S2(BANDWIDTH SELECTOR) ARE FRONT PANEL ADJUSTMENT

4. REFERENCE C16 NOT USED

3. HIGHEST REFERENCE DESIGNATORS USED: C88, CR48, L5, Q40, R150

2. ALL 0/0054 ARE 954.

1. ALL RESISTORS ARE IN OHMS, 1/4W ± 9%, CARBON.

NOTE: UNLESS OTHERWISE SPECIFIED

ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON INPUT LEADS (P.N. AND GUARD) SHORTED TOGETHER

ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.

| | | | |
|---|---|---|---|
| 402311 | 2650-V2 | REF | REF |
| NEXT ASSY | USED ON | MA | FA |
| APPLICATION | | QTY REQD | |

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.02, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES ±1°

MATERIAL

FINISH

CONTRACT NO.

DRAWN T.T. Berg 1-21-67

CHECK M. Marquis 5/14/67

ENGR

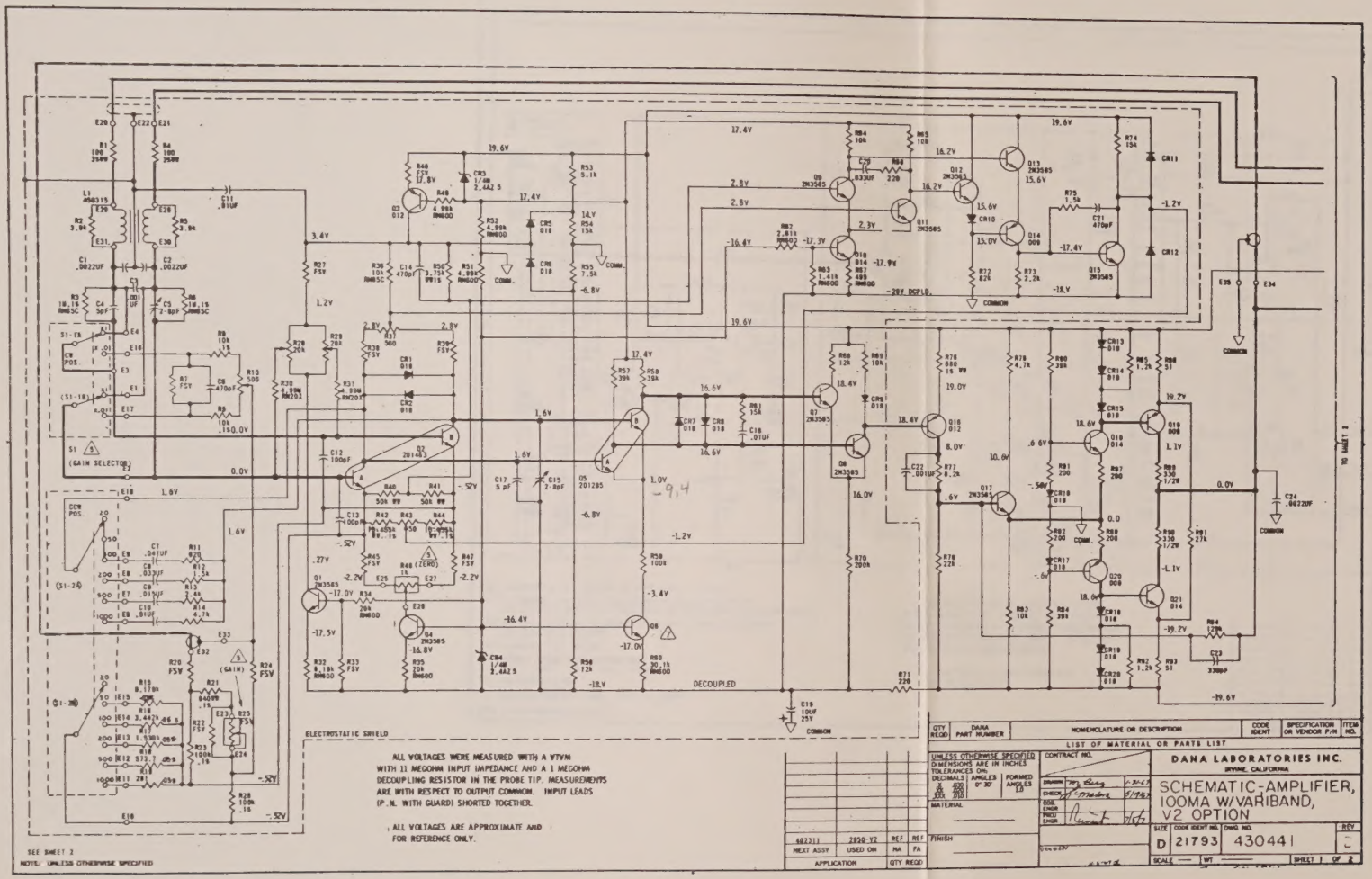
PROJ ENGR 7/5/67

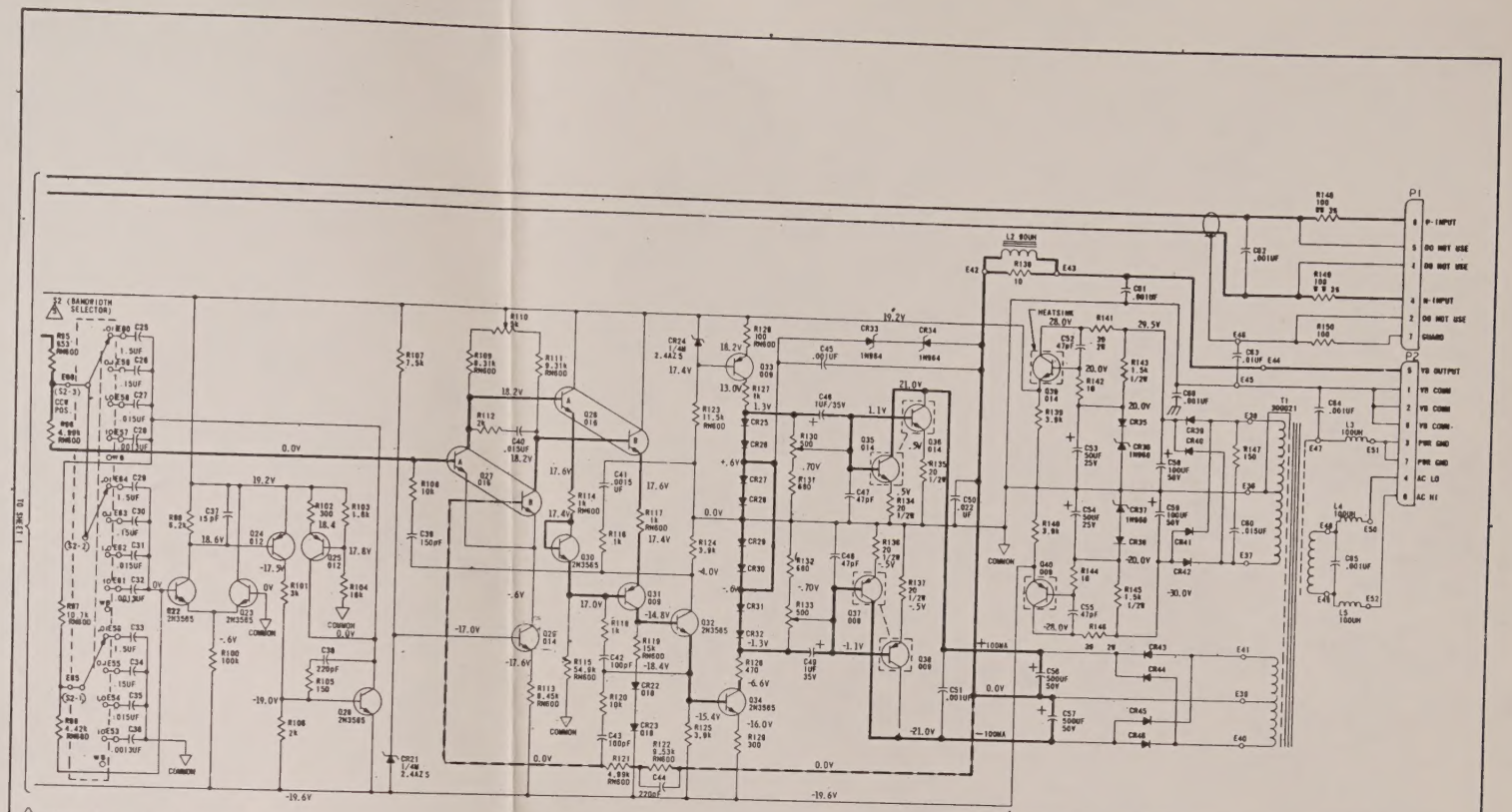
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

# SCHEMATIC-AMPLIFIER, 100MA O.P. W/VARIBAND, V2 OPTION

| SIZE | CODE IDENT NO. | DWG NO. | REV |
|---|---|---|---|
| D | 21793 | 430441 | |

SCALE — WT — SHEET 2 OF 2


ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. WITH GUARD) SHORTED TOGETHER.
ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.
ELECTROSTATIC SHIELD
DECOUPLED
COMMON
(GAIN SELECTOR)
(GAIN)
TO SHEET 2
SEE SHEET 2
NOTE: UNLESS OTHERWISE SPECIFIED
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC-AMPLIFIER, 100MA W/VARIBAND, V2 OPTION
D 21793 430441
SHEET 1 OF 2




TO SHEET 1

⚠1 TRANSISTOR Q7 IS A SELECTED 014 TRANSISTOR. (P/N 200078)

6. "E" NUMBERS DENOTE EYELETS AND CORRESPOND TO POINTS ON PC BRD. SEE ASST DWGS 402312 (BASIC BRD ASSY) AND 402311 (BRD ASST W/OPTION ADDED).

⚠5 R25(GAIN), R46(ZERO), S1(GAIN SELECTOR) AND S2(BANDWIDTH SELECTOR) ARE FRONT PANEL ADJUSTMENT

4. REFERENCE: C16 NOT USED.

3. HIGHEST REFERENCE DESIGNATORS USED: C88, CR48, L5, Q40, R158

2. ALL DIODES ARE 914.

1. ALL RESISTORS ARE IN OHMS, 1/4W ± 5% CARBON.

NOTE: UNLESS OTHERWISE SPECIFIED

ALL VOLTAGES WERE MEASURED WITH A VTVM WITH 11 MEGOHM INPUT IMPEDANCE AND A 1 MEGOHM DECOUPLING RESISTOR IN THE PROBE TIP. MEASUREMENTS ARE WITH RESPECT TO OUTPUT COMMON. INPUT LEADS (P.N. AND GUARD) SHORTED TOGETHER.

ALL VOLTAGES ARE APPROXIMATE AND FOR REFERENCE ONLY.

| QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO. |
|---|---|---|---|---|---|

LIST OF MATERIAL OR PARTS LIST

| 402311 | 2650-V2 | REF | REF |
|---|---|---|---|
| NEXT ASSY | USED ON | MA | FA |
| APPLICATION | | QTY REQD | |

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS/ ANGLES .XX ±.020 .XXX ±.010 FORMED ANGLES 0° 30' 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN T.Berg 1-21-77
CHECK A.Magnie 1/21/77
CDE ENGR
PROJ ENGR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC-AMPLIFIER, 100MA O.P. W/VARIBAND, V2 OPTION

SIZE D | CODE IDENT NO. 21793 | DWG NO. 430441 | REV

SCALE — | WT — | SHEET 2 OF 2

DANA®

MP MASTER
MA31118